

Concept of Operations

for the Next Generation Air Transportation System

Joint Planning and Development Office | Version 3.2



Next Generation Air Transportation System
Joint Planning and Development Office

NextGen

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Preface

- 2 The Joint Planning and Development Office (J PDO) is continuing to refine a Concept of
3 Operations (ConOps) for the Next Generation Air Transportation System (NextGen). This
4 version of the ConOps provides an overall, integrated view of NextGen operations for the 2025
5 time-frame, including key transformations from today's operations.
- 6 The development of the ConOps is an iterative and evolutionary process that encompasses the
7 input and feedback of the aviation community. Version 3.2 of the document includes accepted
8 comments resulting from an internal review and an expanded vision of the NextGen concepts
9 and capabilities. Interested individuals can find details of the J PDO comment and review process
10 at jpe.jpdo.gov under the Joint Planning Environment (JPE) section.

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Document Revision Register

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0.1	Initial document that includes the major “day-of-flight” air navigation elements that support operational activities of a flight moving from “block to block”	JPDO Staff and Integrated Product Teams	May 9, 2006
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Executive Summary

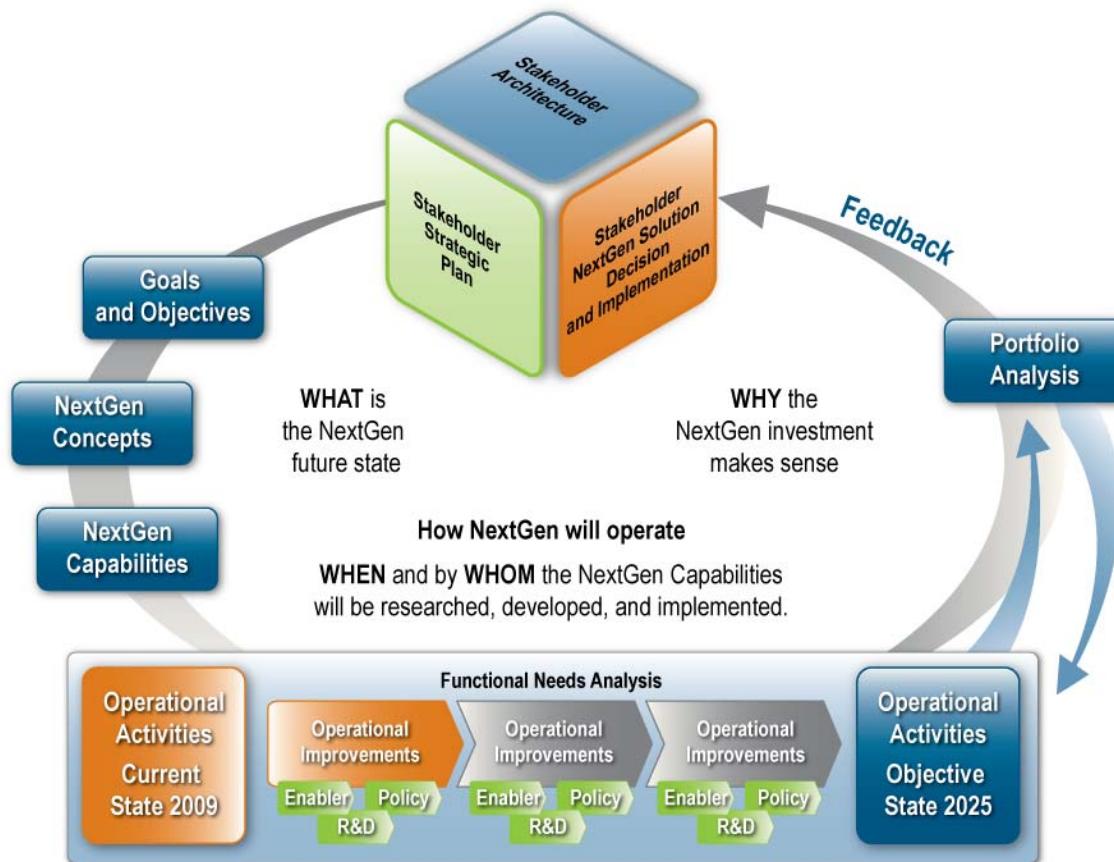
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154 The U.S. air transportation system is under significant stress. With demand in aircraft operations
155 expected to grow significantly through the 2025 time frame, there are well-founded concerns that
156 the current air transportation system will not be able to accommodate forecasted growth. Many
157 legacy systems are unable to process and provide flight information in real-time. Current
158 processes and procedures do not provide the flexibility needed to meet these growing
159 requirements. New security requirements are affecting the ability to move people and cargo
160 efficiently. In addition, the growth in air transportation has heightened community concerns over
161 aircraft noise, air quality and climate impacts, and congestion. New technologies and processes
162 are necessary to meet the need for increased capacity and efficiency, while maintaining safety
163 and mitigating environmental impacts. In response to these concerns, the Joint Planning and
164 Development Office (J PDO) developed the Next Generation Air Transportation System
165 (NextGen) Concept of Operations (ConOps).

166 The ConOps serves as a steering vision for 2025. It is not intended to describe the specific details
167 needed for program planning or implementation. Its intended outcome is to provide a baseline,
168 that forms a widely understandable summary of the 2025 NextGen goals, objectives, concepts,
169 capabilities, and planned transformations needed to realize the NextGen vision.

170

Figure ES-1 J PDO NextGen Planning



171

172 A combination of new procedures and technological advances currently developed, deployed or
 173 planned for the National Airspace System (NAS) make NextGen Goals attainable. The *Next*
 174 *Generation Air Transportation System's Integrated Plan* (2004) and *NGATS 2005 Progress*
 175 *Report* detailed the problems facing the NAS and identified six goals, and 19 objectives to
 176 achieve the NextGen vision:

177 **Table ES-1 NextGen Goals and Objectives**

GOALS	OBJECTIVES
Retain U.S. Leadership in Global Aviation	Retain role as world leader in aviation Reduce costs of aviation Enable services tailored to traveler and shipper needs Encourage performance-based, harmonized global standards for U.S. products and services
Expand Capacity	Satisfy future growth in demand and operational diversity Reduce transit time and increase predictability Minimize impact of weather and other disruptions
Ensure Safety	Maintain aviation's record as safest mode of transportation Improve level of safety of U.S. air transportation system Increase level of safety of worldwide air transportation system
Protect the Environment	Reduce noise, emissions, and fuel consumption Balance aviation's environmental impacts with other societal objectives
Ensure Our National Defense	Provide for common defense while minimizing civilian constraints Coordinate a national response to threats Ensure global access to civilian airspace
Secure the Nation	Mitigate new and varied threats Ensure security efficiently serves demand Tailor strategies to threats, balancing costs and privacy issues Ensure traveler and shipper confidence in system security

178 The following eight key NextGen concepts were identified as necessary to achieve the NextGen
 179 goals and objectives. A brief description of the NextGen concepts is contained below:

- 180 • **Net-Centric Operations (Network-Enabled Information Access)** - provides secure
 181 information access, available in real-time for Communities of Interest (COI) and air
 182 transportation domains. This greater accessibility enables better distribution of
 183 information and improves the speed, efficiency, and quality of the decision-making
 184 process.
- 185 • **Performance-Based Operations and Services** – through regulations and procedural
 186 requirements in addition to technology or equipment, minimum performance levels are
 187 required to maximize capacity in congested airspace during specific periods. Service
 188 providers can define capability improvements in terms of users' existing equipage
 189 maximizing the value of the service providers' and users' investments.
- 190 • **Weather Assimilated into Decision Making** – directly applies both probabilistic and
 191 observed weather information to Air Traffic Management (ATM) decision tools,
 192 increasing the effective use of weather information and minimizing the adverse effects.
- 193 • **Layered, Adaptive Security** – deploys a multi-layered security system (including
 194 techniques, tools, sensors, processes, information, and a robust integrated risk

- 195 management [IRM] system) that leverages technology and net-centric information
196 sharing to deter threats proportional to the assessed risk.
- 197 • **Positioning, Navigation, and Timing (PNT) Services (Broad-Area Precision**
198 **Navigation**) - utilizes satellite navigation to accurately and precisely determine one's
199 current location and orientation in relation to one's desired path and position.
 - 200 • **Trajectory-Based Operations (TBO)** - dynamically adjusts a flight path in space
201 (longitude, latitude, altitude) and time using a known position and intent; more accurately
202 allowing the decrease in separation and increase in NAS capacity.
 - 203 • **Equivalent Visual Operations (EVO)** - provides aircraft operators with the critical
204 visual information needed to maintain safe distances from other aircraft, terrain, and
205 airport infrastructure during night and instrument metrological conditions utilizing
206 advanced cockpit technologies supported by ground based infrastructure.
 - 207 • **High-density Arrival/Departure Operations** – utilizes advanced technologies and
208 procedures in congested airspace/airports to improve terminal aircraft movements,
209 reducing spacing and separation requirements, while improving arrival and departure
210 sequencing.

211 These transformational concepts described above are the driving factors for NextGen. They
212 encompass air traffic management, airports, security, and environmental management, to achieve
213 greater safety and efficiency; protect our airspace, people and infrastructure; and leverage
214 innovative technologies, such as satellite-based navigation and surveillance in order to create a
215 scalable NAS. Furthermore, these concepts are flexible enough to manage variations in demand,
216 capacity, and aircraft fleet types both manned and unmanned, seamlessly integrating civil,
217 commercial, and military operations.

218 Building upon the NextGen concepts, this ConOps is organized around a set of NextGen
219 capabilities which detail the overall effect desired through the implementation of specific
220 standards, processes and conditions. The nine NextGen capabilities identified by the JPDO
221 provide:

	Collaborative Capacity Management		Air Transportation Security
	Collaborative Flow Contingency Management		Improved Environmental Performance
	Efficient Trajectory Management (TM)		Improved Safety Operations
	Flexible Separation Management (SM)		Flexible Airport Facility and Ramp Operations



Integrated NextGen Information

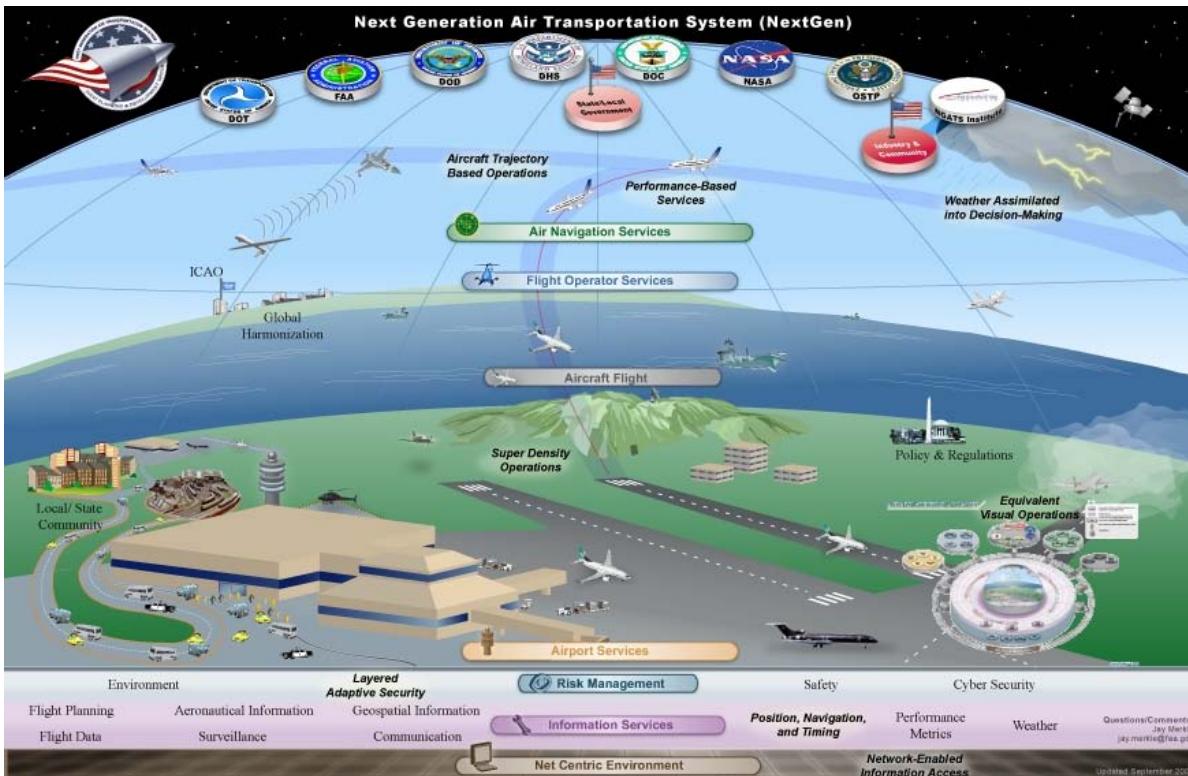
222 NextGen capabilities emphasize system flexibility, scalability, robustness, and resiliency. They
223 also stress the importance of distributed decision making, international coordination, increased
224 user focus, and the provisioning of information to users while reducing the need for government
225 intervention and resource control.

226 NextGen capabilities create a top-down, architectural perspective, laying out a performance-
227 based rationale. The ConOps expresses each capability in operational terms that are implemented
228 through various combinations of operational improvements, enabling solutions, policies,
229 programs, and systems. With NextGen capabilities, the JPDO incorporates a planning framework
230 to organize the collection of pertinent information to provide a coherent and compelling value
231 proposition for the 2025 air transportation system. The nine NextGen capabilities provide clear
232 alignment between the investment portfolio and the resulting value to the following stakeholders:

- 233 • **Airport Communities** - cities and towns located in the vicinity of airports that have a
234 vested interest in and are affected by the operation of the airport
- 235 • **Airport Operators** - responsible for enabling passenger, flight, and cargo operations
236 conducted within an airport with consideration for safety, efficiency, resource limitations,
237 and local environmental issues
- 238 • **Airport Tenants** - who are involved in airport operations, such as fueling, maintenance
239 or catering services
- 240 • **Air Navigation Service Provider (ANSP)** - engaged in providing ATM and Air Traffic
241 Control (ATC) services for flight operators for the purpose of safe and efficient flight
242 operations. ATM responsibilities include Communications, Navigation, and Surveillance
243 (CNS). They also include ATM facility planning, investment, and implementation;
244 procedure development and training, and ongoing system operation and maintenance of
245 seamless CNS/ATM services.
- 246 • **Users** - including civil, government, and military, using NAS services.
- 247 • **Flight Operators** - responsible for planning and operating a flight within the NAS. This
248 includes flight crews, Flight Operations Centers (FOC), private, business, scheduled air
249 transport, government, and military operators.
- 250 • **Manufacturers** - who produce items that support flight operations to include: airframes,
251 aircraft engines, avionics, aircraft systems and parts, airport and ATM equipment and
252 infrastructure, Decision Support Systems (DSS), and other components.
- 253 • **Resource Owners** - responsible for making investment decisions related to development
254 and implementation.
- 255 • **Regulatory Authorities** - responsible for governing aspects of the overall performance
256 of the aviation industry including safety, security, standardization, certification,
257 environmental effects, and international trade.

- **Researchers** - engaged in conducting Research and Development (R&D) activities that support the evolution of the air transportation system, including academia and government organizations.
 - **Security and Defense Providers** - responsible for national security and homeland defense, law enforcement, and information security, as well as the physical and operational security of the NAS.
 - **Weather Service Providers** - engaged in the provision of aviation weather products.

Figure ES-2 NextGen Community Model



The transformation from clearance-based operations to TBO, as required by demand and complexity, increases system capacity, flow management, and efficiency. Advancements in aircraft systems allow for reduced separation and facilitate the transition from rules-based operations to performance-based operations. In addition, the transition of separation responsibility from the controller to the flight crew, in certain areas, allows controllers to focus on overall flow instead of individual flight management.

Airports, which incorporate Air Traffic Management (ATM), security, and environmental goals, are the nexus of many of the NextGen transformational elements. New technology and procedures will improve access to airports, enabling better utilization of existing infrastructure. Accordingly, the sustainability and advancement of the airport system is critical to the growth of the NAS. A preservation program to increase community support and protect against encroachment will enhance sustainability of existing airports. Finally, new airport infrastructure will be developed using a comprehensive planning architecture that integrates facilities, finance,

280 regional systems, and environmental improvements to enable a more efficient, flexible, and
281 responsive system.

282 At the heart of the NextGen concept is an information-sharing component known as Net Centric
283 Operations (NCO). Its features adapt to growing operations and shifts in demand, making
284 NextGen a scalable system. NCO also provides the foundation for robust, efficient, secure, and
285 timely flow of information to and from a broad community of users and individual subscribers.
286 This flow results in a system that minimizes duplication, achieves integration, and facilitates
287 distributed decision making by ensuring that all users have relevant and reliable information
288 upon which to base a decision.

289 Embedded in NCO is Shared Situational Awareness (SSA). SSA offers a suite of tools and
290 information designed to provide participants with real-time aeronautical and geospatial
291 information, communicated and interpreted electronically without the need for human
292 intervention. A reliable, common weather picture provides data and automatic updates to a wide
293 range of users, aiding optimal air transportation decision making. Additionally, PNT services
294 reduce dependence on costly, ground-based navigational aids by providing users with a more
295 precise and reliable source of global positioning and timing information. This allows users to
296 accurately and efficiently determine their orientation, course, and speed necessary to arrive at
297 their desired destination. Real-time situational awareness integrates cooperative and non-
298 cooperative surveillance data from all air vehicles to safely navigate in the NAS.

299 Security services are provided by a risk-informed security system that deploys multiple
300 technologies adaptively scaled and arranged to defeat a given threat. New policies and
301 procedures also aid in passenger screening and checkpoint responsibilities. Baggage screening
302 improvements include integrated Chemical, Biological, Radiological, Nuclear, and high-yield
303 Explosives (CBRNE) detection in a range of sizes that facilitates portability and remote
304 screening.

305 The development and implementation of an integrated environmental management system
306 proactively addresses aviation ecological issues. Technologies incorporated before and during
307 operations enable optimized route selection, as well as landing and take-off patterns based on a
308 range of data feeds to reduce noise, air emissions and fuel burn, while increasing operational
309 efficiency. At airports, a flexible, systematic approach identifies and manages environmental
310 resources that are critical to sustainable growth. Additionally, aircraft design continues to
311 incorporate environmental considerations that proactively address noise reduction, while
312 reducing aircraft engine emissions.

313 Aviation safety steadily improves to accommodate the anticipated growth in air traffic through
314 an integrated Safety Management System (SMS). A national aviation safety policy implements
315 and oversees safety requirements for all participants. This policy encourages a safety
316 improvement culture and uses non-reprisal reporting systems to identify concerns or incidents.
317 Safety assurance focuses on a holistic view of operators' processes and procedures, rather than
318 the individual pieces of the system. Prognostic assessments using modeling, simulation, data
319 analysis and data sharing improve Safety Risk Management (SRM). Technological advances will

320 be utilized in both airborne and ground systems to provide improved decision making by
321 improving situational awareness and safety for the flight crews and controllers.

322 NextGen is a complex system with many public and private sector stakeholders that must
323 smoothly, promptly, and capably integrate with the envisioned changes to the global air
324 transportation system. Federal agencies, national defense, homeland security, ATM, scheduled
325 air transport and General Aviation (GA) operators, and airports must work together to support
326 passenger, cargo, recreational, and military operations. Through a seamless and transparent
327 information infrastructure and shared services environment, users gain a common picture of the
328 operational information necessary to safely and efficiently perform in the NextGen NAS.
329 Implementation of these integrated NextGen capabilities will enable us to meet the nation's
330 future demand for the most effective, efficient, safe, and secure air transportation system.

331

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333

334



1 Introduction

335

The Next Generation Air Transportation System (NextGen) Concept of Operations (ConOps) describes the operational concept as envisioned in the 2025 time frame. It provides a robust framework for the aviation stakeholder community to discuss the vision of improvements needed to achieve national and global goals for air transportation. The concepts and capabilities presented in this ConOps provide an operational view of how air traffic and airports are managed and how security is provided to protect our airspace and people. It also depicts how goals for protecting and enhancing our environment are achieved, and how advanced technologies and processes in government and civil organizations provide increased safety and efficiency.

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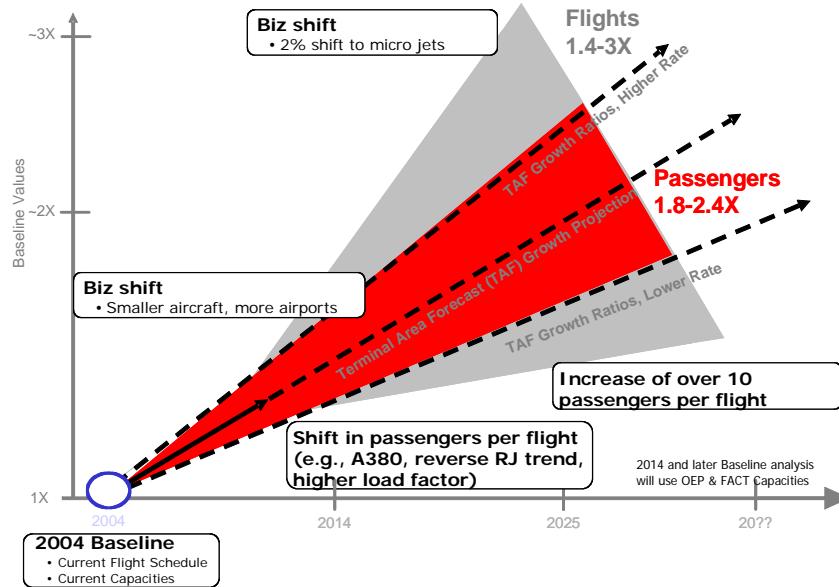
1.1 NEXTGEN ENVIRONMENT

346

In the NextGen time-frame, demand for air transportation and other airspace services will grow from today's levels, in terms of passenger volume, amount of cargo shipped, and overall flights. With respect to air traffic, changes will occur not only in the number of flights, but also in the characteristics of those flights. NextGen planning is required to meet anticipated demand. Figure 1-1 illustrates some of the potential variations in demand characteristics. NextGen must be flexible enough to manage variations in number of passengers, types of aircraft flown, and overall number of flights.

353

Figure 1-1 Planning for a Range of Futures



354

355

Overall, NextGen will accommodate significantly increased traffic levels with broader aircraft performance envelopes and more operators within the same airspace, increasing the complexity and coordination requirements of ATM. The NextGen concepts and capabilities will be critical to meet NextGen goals and objectives.

359 **1.2 BACKGROUND**

360 Public Law 108-176, Vision 100--Century of Aviation Reauthorization Act, December 12, 2003,
361 established a mandate for the design and deployment of an air transportation system to meet the
362 nation's needs in 2025. The legislation also established the Joint Planning and Development
363 Office (JPDO) to manage the public/private partnership and coordinate the transformation efforts
364 required to carry out the NextGen mission.
365

366 The JPDO is a joint initiative of the Departments of
367 Commerce (DOC), Defense (DOD), Homeland
368 Security (DHS), and Transportation (DOT), as well as
369 the Federal Aviation Administration (FAA), the
370 National Aeronautics and Space Administration
371 (NASA), Office of the Director of National
372 Intelligence (ODNI), and the White House Office of
373 Science and Technology Policy (OSTP). In addition to
374 these government agencies, the JPDO includes the
375 NextGen Institute, which provides access to the
376 knowledge, skills, and subject matter expertise of the
377 private aviation stakeholder communities.
378 Furthermore, the NextGen Institute facilitates, two-way
379 communication process between the government and
380 the private sector.

The U.S. aviation system must transform itself and be more responsive to the tremendous social, economic, political, and technological changes that are evolving worldwide. We are entering a critical era in air transportation, in which we must either find better, proactive ways to work together or suffer the consequences of ... [losing] \$30B annually due to people and products not reaching their destinations within the time periods we expect today.

– *NGATS Integrated Plan*, 2004

381 In accordance with the requirements of the legislation, on December 12, 2004, the Secretary of
382 Transportation and the FAA Administrator delivered to Congress the *Next Generation Air
383 Transportation System Integrated Plan (NGATS Integrated Plan)*. This plan sets forth the
384 National Vision for Air Transportation in 2025, as well as JPDO's approach to achieving air
385 transportation system transformation. The vision emphasizes a shift in how information is
386 accessed, allowing those who use the air transportation system to have more direct access to
387 information affecting their operations.
388

389 The *NGATS Integrated Plan* clearly defines the problem: The U.S. air transportation system, as
390 we know it, is under significant stress. With demand in aircraft operations expected to grow
391 significantly through the 2025 time frame, there are well-founded concerns that the current air
392 transportation system will not be able to accommodate this growth. Many legacy systems are
393 unable to process and provide flight information in real time, while current processes and
394 procedures do not provide the flexibility needed to meet growing demand. New security
395 requirements are affecting the ability to move people and cargo quickly and efficiently. In
396 addition, the growth in air transportation has elicited community concerns over aircraft noise, air
397 quality, and congestion. New technologies and processes are required to meet the need for
398 increased capacity and efficiency while maintaining safety.
399

400 The *NGATS Integrated Plan* recognizes these national needs and identifies six national and
401 international goals and 19 objectives for successful NextGen implementation (Table 1-1.)

402 Separately, each goal represents an ambitious agenda. Meeting these NextGen goals and
403 objectives requires a transformation that embraces new concepts, technologies, networks,
404 policies, and business models.

405 **Table 1-1 NextGen Goals and Objectives**

GOALS	OBJECTIVES
Retain U.S. Leadership in Global Aviation	Retain role as world leader in aviation Reduce costs of aviation Enable services tailored to traveler and shipper needs Encourage performance-based, harmonized global standards for U.S. products and services
Expand Capacity	Satisfy future growth in demand and operational diversity Reduce transit time and increase predictability Minimize impact of weather and other disruptions
Ensure Safety	Maintain aviation's record as safest mode of transportation Improve level of safety of U.S. air transportation system Increase level of safety of worldwide air transportation system
Protect the Environment	Reduce noise, emissions, and fuel consumption Balance aviation's environmental impacts with other societal objectives
Ensure Our National Defense	Provide for common defense while minimizing civilian constraints Coordinate a national response to threats Ensure global access to civilian airspace
Secure the Nation	Mitigate new and varied threats Ensure security efficiently serves demand Tailor strategies to threats, balancing costs and privacy issues Ensure traveler and shipper confidence in system security

406
407 The *NGATS Integrated Plan* lays out challenges facing the air transportation system. It also
408 highlights the motivation for the air transportation system to grow and continue to serve the
409 national and international community while responding to tremendous social, economic,
410 political, environmental, and technological changes worldwide. During the next two decades,
411 demand is expected to increase, creating a need for a system that (1) supports increased capacity,
412 (2) is agile enough to accommodate a changing fleet that includes Very Light Jets (VLJ),
413 Unmanned Aircraft Systems (UAS), and space vehicles, (3) addresses security and national
414 defense requirements, and (4) can ensure that aviation remains an economically viable industry.

415 **1.2.1 Key Characteristics of NextGen**

416 To meet the goals and objectives, the NextGen vision involves a transformed air transportation
417 system that allows all communities to participate in the global marketplace.

418 **1.2.1.1 User Focus**

419 A major theme is an emphasis on providing more flexibility and tailored information to users,
420 while reducing the need for government intervention and control of resources. NextGen enables
421 operational and market freedom through greater situational awareness and data accessibility. It
422 aligns government structures, processes, strategies, and business practices with customer needs.

423 With a focus on users, NextGen is also more agile in responding to user needs. Capacity is
424 expanded to meet demand by investing in new infrastructure and shifting resources (e.g.,
425 airspace structures and other assets). More efficient procedures allow reductions in separation
426 between aircraft to safely increase airport throughput thereby minimizing the effects of
427 constraints such as weather on overall system capacity. The system will be flexible enough to
428 cost effectively adjust to varying levels of demand, allowing more creative sharing of airspace
429 capacity for law enforcement, military, scheduled air transport, and General Aviation (GA) users.
430 Users will have greater access to airspace unless restrictions are required to address a safety or
431 security need.

432 Aircraft must have a wider range of capabilities (e.g. improved avionics, airframes, and engines)
433 than are available today. These capabilities must support varying levels of total system
434 performance via onboard systems and associated crew training. Many aircraft will have the
435 ability to perform self-separation, spacing, and merging tasks to precisely navigate and execute
436 4DT. Along with navigation accuracy, these aircraft will have improved levels of cooperative
437 surveillance performance via transmission and receipt of real-time cooperative surveillance
438 information. Aircraft will also have the ability to observe and share up-to-date weather
439 information. In terms of flight operational performance, a wider range of improvements in cruise
440 speed, cruise altitudes, turn rates, climb and descent rates, stall speeds, reduced noise/ emissions
441 will exist. Aircraft without an on-board pilot (e.g., Remotely Piloted Aircraft [RPA], UAS) will
442 operate among traditional manned, piloted aircraft. Domestic supersonic cruise operations are
443 also expected to be more prevalent.

444 Operators will have a diverse range of abilities and modes that will focus on the user. Many
445 operators will have sophisticated flight and fleet planning capabilities to manage their operations.
446 Operations will include traditional hub/spoke operations, point-to-point flights, military, training,
447 and recreational flying. Operational demand may vary among highly structured flights (e.g.,
448 today's air carrier, cargo, or operators), irregularly scheduled flights with frequent trips to regular
449 destinations with variable dates and times (e.g., air taxi operators or business operators with
450 regular customers), and unscheduled, itinerant flights driven by individual events (e.g., lifeguard
451 flights, personal trips, or law enforcement missions). In addition, new types of operations,
452 including widespread UAS activity that perform various government and civil missions (e.g.,
453 National Defense, border security, disaster response, public safety, search and rescue,
454 environmental research, and cargo delivery) and more frequent commercial space vehicle
455 operations (e.g., suborbital flights to low-earth-orbit payload delivery and return missions) will
456 make the skies more diverse. Commercial space transport operations will grow, increasing
457 pressures to balance competing needs for airspace access and efficiency.

458 ***1.2.1.2 Distributed Decision Making***

459 To the maximum extent possible, decisions are made at the local level with an awareness of
460 system-wide implications. This includes an increased level of decision-making ability by the
461 flight crew and Flight Operations Centers (FOC). Stakeholder decisions are informed by access
462 to a comprehensive information exchange environment and a transformed Collaborative
463 Decision-Making (CDM) process that allows wide access to information by all parties (both
464 airborne and on the ground). Information is timely, relevant, accurate, quality assured, and within

465 established security procedures. Decision makers have the ability to request information when
466 they need it, publish information as appropriate, and use subscription services to receive desired
467 information automatically. This information environment enables more timely access to
468 information and increased situational awareness while providing consistency of information
469 among decision makers. As a result, decisions can be made more quickly, required lead times
470 for implementation can be reduced, responses can be more specific, and solutions can be more
471 flexible to change. To ensure that locally developed solutions do not conflict, decision makers
472 use National Airspace System (NAS)-wide objectives and test solutions to identify interference
473 and conflicts with other initiatives.

474 **1.2.1.3 Integrated Safety Management System (SMS)**

475 Safety is promoted through use of an integrated SMS approach for identifying and managing
476 potential hazards. This includes equipment, organizational, operational or systems problems.
477 Specifically, NextGen uses a formal, top-down, business-like approach to manage safety risk,
478 which includes systematic procedures, practices, and policies for safety management.

479 Components of SMS include the following items:

- 480 • **Safety Policy.** Defines how the organization will manage safety as an integral part of its
481 operations, and establishes SMS requirements, responsibilities, and accountabilities.
- 482 • **Safety Risk Management (SRM).** The formal process within the SMS that consists of
483 describing the system; identifying the hazards; and assessing, analyzing, and mitigating
484 the risk. The SRM process is embedded in the processes used to provide the product or
485 service—it is not a separate process.
- 486 • **Safety Assurance.** SMS process management functions that systematically ensure that
487 organizational products or services meet or exceed safety requirements. This includes the
488 processes used to ensure safety, including audits, evaluations, and inspections and
489 encompasses data tracking and analysis.
- 490 • **Safety Promotion.** Training, communication, and dissemination of safety information to
491 strengthen the safety culture and support integration of the SMS into operations.

492 **1.2.1.4 International Harmonization**

493 The ATM system is globally harmonized through collaborative development and implementation
494 of identified best practices in both standards and procedures. International harmonization also
495 requires advocating for the highest operational standards for aircraft operators and Air
496 Navigation Service Providers (ANSF) to ensure a safe and secure global air transportation
497 system. International Civil Aviation Organization (ICAO) Planning and Implementation
498 Regional Groups (PIRG) or multilateral agreements enable the planning and implementation of
499 NextGen transformations to harmonize the application of technology and procedures. This
500 harmonization allows airspace users to realize the maximum benefits of the NextGen
501 transformations.

502 **1.2.1.5 Taking Advantage of Human and Automation Capabilities**

503 NextGen capitalizes on human and automation capabilities to increase airspace capacity,
504 improve aviation safety, and enhance operational efficiency. This capitalization is accomplished

505 by building processes and systems that help humans do what they do best—choose alternatives
506 and make decisions. Additionally, automation systems accomplish what they do best—acquire,
507 compile, monitor, evaluate, and exchange information. Research and analysis will determine the
508 appropriate functional allocation of tasks among ANSP, flight operators, and automation. This
509 includes determining when decision support tools are necessary to support humans (e.g.,
510 identifying conflicts and recommending solutions for pilot approval) and when functions are
511 necessary to be completely automated.

512 ***1.2.1.6 Weather Operations***

513 Users stop seeing weather information as separate data viewed on a “stand-alone” display.
514 Instead, weather information is integrated with decision-oriented automation and human
515 decision-making processes. Improved communications and information sharing allows all
516 stakeholders access to a single authoritative weather source. Weather data is translated into
517 information presented to NAS users and service providers, such as the likelihood of flight
518 deviation, airspace permeability, and capacity. Flight trajectory plans have an increased
519 understanding of the potential severity and probability of weather hazards. As a result, less
520 airspace is constrained because of weather. Operators of aircraft equipped with capabilities to
521 mitigate the effects of weather may choose to fly through certain weather-impacted areas.

522 Decision Support Systems (DSS) directly incorporate weather data and bypass the need for
523 human interpretation. This allows decision-makers to determine the best response to weather’s
524 potential operational effects (both tactical and strategic) and minimizes the level of traffic
525 restrictions. This integration of weather information, combined with the use of probabilistic
526 forecasts to address weather uncertainty and improved forecast accuracy, minimizes the effects
527 of weather on operations.

528 ***1.2.1.7 Environmental Management Framework***

529 Environmental management is performed in the context of the NextGen objectives. Capacity
530 increases will be consistent with environmental protection goals to allow for sustained aviation
531 growth. New technology, procedures, and policies reduce impacts on community noise and local
532 air quality. They also mitigate water quality impacts, energy use, and climate effects.
533 Environmental compatibility combines improvements in aircraft design, aircraft performance and
534 operational procedures, land use around airports, and policies and incentives to accelerate
535 technology introduction into the fleet. Intelligent flight planning and improved flight
536 management enables the optimization of route selection, landing, and approach procedures based
537 on a range of data, including noise, emissions, and fuel burn, thereby reducing environmental
538 effects. Research and Development (R&D) and refined technology implementation strategies
539 balance near-term technology development and maturity needs with long-term cutting-edge
540 research, helping aircraft keep pace with changing environmental requirements.

541 ***1.2.1.8 Robustness and Resiliency***

542 NextGen is more resilient and robust in responding to failures and/or disruptions to the NAS.
543 This includes contingency measures to provide continuity of operations in the face of major
544 outages, natural disasters, security threats, or other unusual circumstances. Moreover, increased
545 reliance on automation pairs will not require full reliance on human cognition as a backup.

546 NextGen maintains a balance of reliability, redundancy, and procedural backups to ensure safety
547 in the event of individual systems or component failure. Ultimately NextGen provides a system
548 that has high availability and requires minimal time to restore functionality.

549 **1.2.1.9 Scalability**

550 NextGen is adaptable to meet the changes in traffic loads and demands that occur every day and
551 for decades to come, providing an overall system design that can handle a wide range of
552 operations. Increased use of automation, reduced separation standards, high-density
553 arrival/departure operations, and additional runways allow busy airports to move a large number
554 of aircraft through the terminal airspace during peak traffic periods. Each of these features
555 contributes to an environment that supports growth in operations. New improvements, such as
556 Staffed NextGen Towers (SNT), enable the cost-effective expansion of services to a significantly
557 larger number of airports than is possible with traditional methods of service delivery. Because
558 of its scalability, NextGen is able to adapt to changes in short-term or long-term demand, even
559 when the changes are not predicted.

560 **1.2.2 NextGen Planning Organization**

561 To achieve the 2025 vision, goals, and objectives identified in the *NGATS Integrated Plan*,
562 today's systems and processes must be rigorously and systematically transformed through the
563 sustained, coordinated, and integrated efforts of many stakeholders. The NextGen goals
564 identified in the *NGATS Integrated Plan* will be achieved through the deployment of new
565 operational concepts and capabilities as well as procedures and technologies to manage
566 passenger, cargo, and aircraft operations. To support this endeavor, the JPDO has developed and
567 will continue to refine key areas of planning which include:

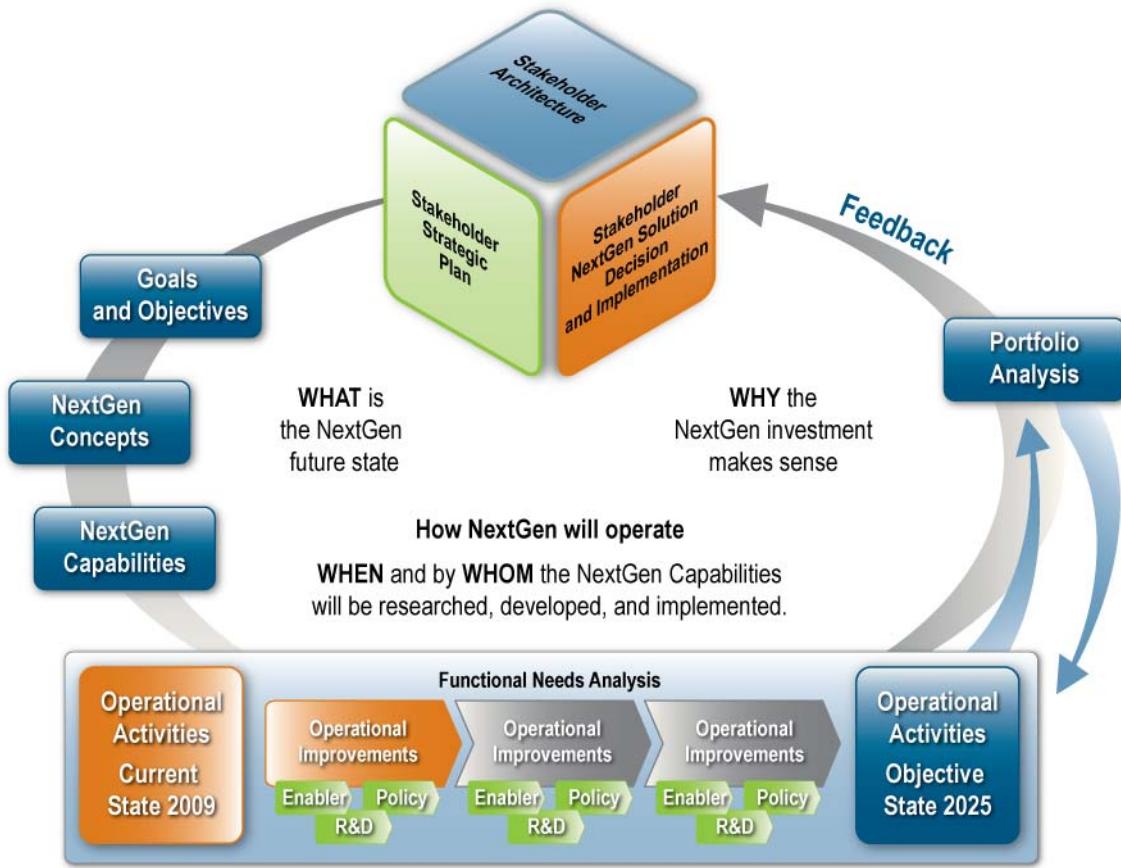
- 568 • ConOps
569 • Enterprise Architecture (EA)
570 • Integrated Work Plan (IWP)
571 • Portfolio Analysis

572 As identified in Figure 1-2, these planning areas describe “what” the NextGen end-state will be,
573 “how” it will operate, and “when” capabilities and improvements will be introduced. They also
574 reference “who” will be responsible for implementing the capabilities and improvements, and
575 “why” the investment is beneficial to the nation.

576

577

578

Figure 1-2 JPDO NextGen Planning

579

580 The intent of this ConOps is to describe a vision that meets these national goals and to establish
581 how to transform the air transportation system. Part of this transformation involves integrating
582 and reshaping air transportation so that the entire system operates as an interconnected structure.
583 In many cases, this builds on visionary material that captures the aviation community's goals for
584 different aspects of transportation. For ATM, many of the concepts build on the *National*
585 *Airspace System (NAS) Concept of Operations and Vision for the Future of Aviation* and the
586 *ICAO Global ATM Operational Concept*, which represents a globally harmonized set of
587 concepts for the future.¹

588 The JPDO recognizes the need to develop an interoperable system with the international
589 community because the effects of implementing NextGen technologies and procedures
590 throughout the NAS will extend far beyond the borders of the United States. Coordination and
591 collaboration on policy, system standards, operational procedures, avionics capabilities, and
592 equipage milestones across international borders will promote global harmonization.

593 The overarching international aim of NextGen is the harmonization of systems and procedures to
594 ensure civil and military interoperability across international boundaries and timely adoption of

¹ RTCA, 2002

595 global standards and operational procedures that satisfy U.S. requirements. In order to realize
596 NextGen's full benefits, efforts must be taken to ensure it will be capable of transcending
597 borders.

598 NextGen encompasses all aerospace transportation, not just aviation, and not just ATM. In
599 addition to technological innovation, NextGen emphasizes changes in organizational structure,
600 processes, strategies, policies, and business practices. Where applicable, NextGen includes shifts
601 in government and private sector roles that are required to exploit new technological solutions.

602 1.3 NEXTGEN STAKEHOLDERS

603 The list of key NextGen stakeholders includes:

- 604 • **Airport Communities** - Cities and towns located in the vicinity of airports that have a
605 vested interest in and are affected by the operation of the airport.
- 606 • **Airport Operators** - responsible for enabling passenger, flight, and cargo operations
607 conducted within an airport with consideration for safety, efficiency, resource limitations,
608 and local environmental issues.
- 609 • **Airport Tenants** - who are involved in airport operations, such as fueling, maintenance
610 or catering services.
- 611 • **ANSP²** - engaged in providing ATM and Air Traffic Control (ATC) services for flight
612 operators for the purpose of safe and efficient flight operations. ATM responsibilities
613 include Communications, Navigation, and Surveillance (CNS). They also include ATM
614 facility planning, investment, and implementation; procedure development and training,
615 and ongoing system operation and maintenance of seamless CNS/ATM services.
- 616 • **Users** - including civil, government, and military, using NAS services.
- 617 • **Flight Operators** - responsible for planning and operating a flight within the NAS. This
618 includes flight crews, FOC, private, business, scheduled air transport, government, and
619 military operators.
- 620 • **Manufacturers** - who produce items that support flight operations to include: airframes,
621 aircraft engines, avionics, aircraft systems and parts, airport and ATM equipment and
622 infrastructure, DSSs, and other components.
- 623 • **Resource Owners** - responsible for making investment decisions related to development
624 and implementation.
- 625 • **Regulatory Authorities** - responsible for governing aspects of the overall performance
626 of the aviation industry including safety, security, standardization, certification,
627 environmental effects, and international trade.
- 628 • **Researchers** - engaged in conducting R&D activities that support the evolution of the air
629 transportation system, including academia and government organizations.

² Air Navigation Service Providers (ANSP) includes both civilian and military personnel.

- 630 • **Security and Defense Providers** - responsible for national security and homeland
631 defense, law enforcement, information security, as well as the physical and operational
632 security of the NAS.
- 633 • **Weather Service Providers** - engaged in the provision of aviation weather products.

634 1.4 OVERVIEW OF NEXTGEN CONCEPTS AND CAPABILITIES

635 As previously described, this ConOps provides an overall, integrated view of operations in the
636 2025 time frame. Many future outcomes are possible but they will depend on the insights gained
637 by the evolution of this ConOps.

638 The NextGen goals significantly increase the safety, security, capacity, efficiency, and
639 environmental compatibility of air transportation operations. These benefits can be achieved
640 through a combination of new procedures and advances in the technology deployed to manage
641 passenger, air cargo, and air traffic operations. The *NGATS 2005 Progress Report* identifies the
642 following concepts that will help achieve these goals and objectives:

- 643 • **Net-Centric Operations (Network-Enabled Information Access).** Through network-
644 enabled information access, information is available, securable, and usable in real-time
645 for Communities of Interest (COI) and air transportation domains. This greater
646 accessibility enables better distribution of information and improves the speed,
647 efficiency, and quality of this process. Information can be automatically provided to users
648 with a known need and be available to users not previously identified as new needs arise.
649 Information access improves operational decision making, enabling system operators the
650 use of risk management practices to enhance safety. Cooperative surveillance for civil
651 aircraft operations, where aircraft constantly transmit their position, is used with a
652 separate sensor-based, non-cooperative surveillance system as part of an overall
653 integrated federal surveillance approach.
- 654 • **Performance-Based Operations and Services.** Performance-based operations provide a
655 foundational transformation of NextGen. Regulations and procedural requirements are
656 described in performance terms rather than in terms of specific technology or equipment.
657 Minimum performance levels are expected to be required to maximize capacity in
658 congested airspace during specific periods of time. Service providers can use service tiers
659 to create guarantees for different performance levels so that users can make the
660 appropriate tradeoffs between investments and level of service desired to meet their
661 needs. A benefit of performance-based operations and services is that service providers
662 can define capability improvements in terms of users' existing equipage, thus potentially
663 maximizing the value of the service providers' and users' investments.
- 664 • **Weather Assimilated into Decision Making.** By assimilating weather into decision
665 making, weather information becomes an enabler for optimizing NextGen operations.
666 Directly applying both probabilistic and observed weather information to ATM decision
667 tools increases the effective use of weather information and minimizes the adverse effects
668 of weather on operation.

- **Layered, Adaptive Security.** Layered, adaptive security includes a security system that consists of “layers of defense” (including techniques, tools, sensors, processes, information, and a robust Integrated Risk Management [IRM] system). This type of security system helps reduce the overall risk of a threat reaching its objective while minimally affecting efficient operations. Layered security is additive; failures in any one component should not have a catastrophic effect on other components. For that reason, the system is well suited to handle attacks and incidents, intrusions or attacks with minimal overall disruption. Layered, adaptive security adjusts the deployment of security assets in response to the changing IRM profile of risks; responses to anomalies and incidents are proportional to the assessed risk.
- **Positioning, Navigation, and Timing (PNT) Services (Broad-Area Precision Navigation).** PNT services are near ubiquitous, in accordance with demand and safety considerations, to enable reliable aircraft operations in nearly all conditions. Rather than being driven by the geographic location of a ground-based Navigational Aid (NAVAID), NextGen PNT services allow operators to define the desired flight path based on their own objectives.
- **Trajectory-Based Operations (TBO).** The basis for TBO is knowing each aircraft’s expected flight profile and time information (such as departure and arrival times) beforehand. The specificity of 4DT matches the mode of operations and the requirements of the airspace in which an aircraft operates. A major benefit of 4DT is that it enables service providers and operators to assess the effects of proposed trajectories and resource allocation plans, allowing service providers and operators to understand the implications of demand and identify where constraints need further mitigation.
- **Equivalent Visual Operations (EVO).** Improved real-time information allows aircraft to conduct operations in less than direct visual observation. For aircraft, this capability, in combination with PNT, enables increased accessibility, both on the airport surface and during arrival and departure operations. This capability also enables those providing services at airports (such as ATM or other ramp services) to provide services in all visibility conditions, leading to more predictable and efficient operations.
- **High-density Arrival/Departure Operations.** An even greater need exists to achieve peak throughput performance at the busiest airports, in the most crowded airspace, during peak times. New procedures to improve airport surface movements, reduce spacing and separation requirements, and better manage overall flows in and out of busy metropolitan airspace, maximize the use of the highest-demand airports. Airport terminals also optimize efficiency of egress and ingress, matching passenger and cargo flow to airside throughput while maintaining safety and security levels.

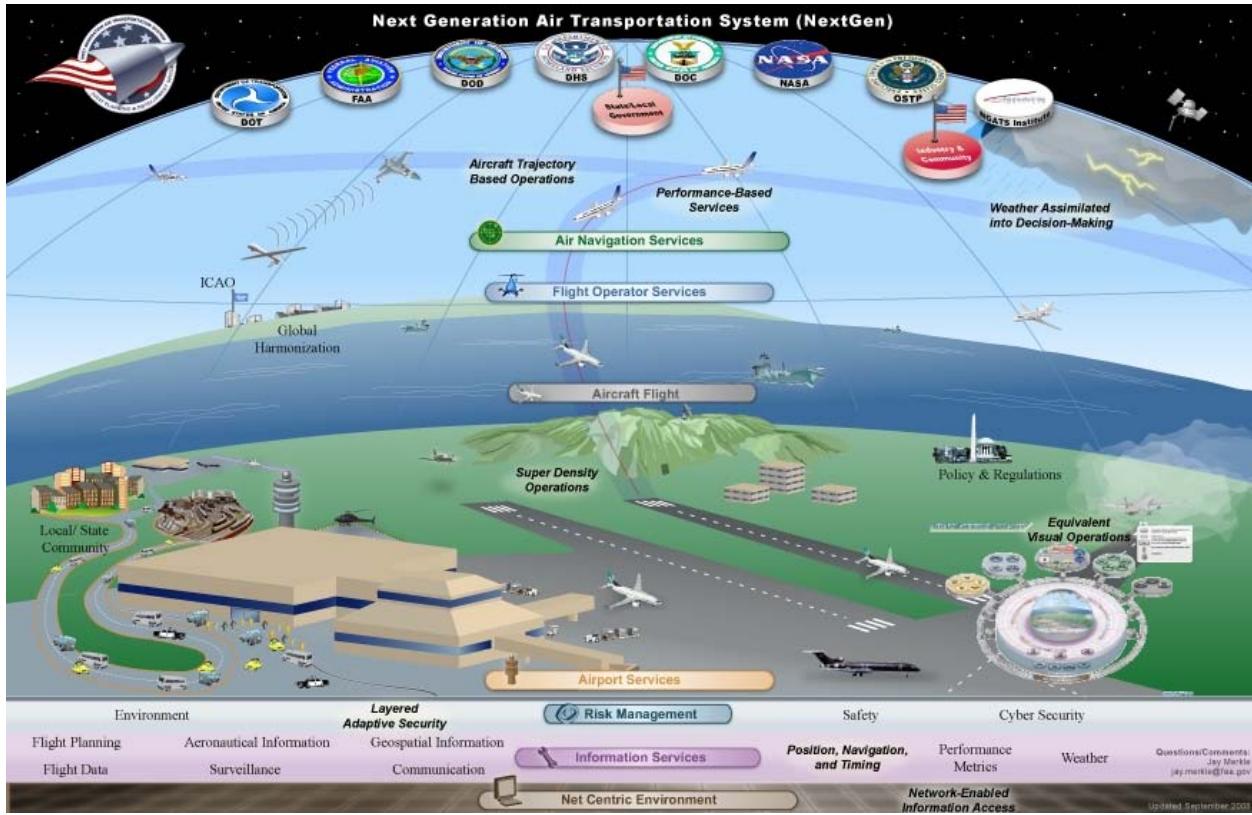
These concepts have been further incorporated into the NextGen capabilities (described further below). These concepts are used as a common framework among the JPDO planning elements to describe, organize, and align the NextGen portfolio.

Figure 1-3 provides an overall operational view of the environment envisioned in 2025. The air transportation system is a complex global system with many public and private sector stakeholders. NextGen integrates national defense and civilian functions to provide globally

711 harmonized services to both civil and military users. The integrated concepts provide the
712 capacity needed to meet the nation's need for an optimized air transportation system in the most
713 effective, efficient, safe, and secure manner possible.

714
715 To help further describe the NextGen concept, the JPDO has identified a comprehensive set of
716 capabilities to provide a framework for synthesizing and aligning the advanced concepts with the
717 NextGen EA and IWP. The capabilities represent transformational improvements to the current
718 air transportation system. Employing various combinations of enabling solutions, such as
719 policies, programs, and systems will make NextGen capabilities a reality.

720 **Figure 1-3 NextGen Community Model**



721

722

723 The nine NextGen capabilities defined by the JPDO provide:



Collaborative Capacity Management (CM) - provides the ability to dynamically balance anticipated/forecasted demand and utilization. It allocates NAS resources through proactive and collaborative strategic planning with enterprise stakeholders and automation (e.g., DSS), that consider airspace and airport design requirements, standards, and configuration conditions. This is all conducted with the consideration of other air transportation system resources.



Collaborative Flow Contingency Management (FCM)- provides optimal, synchronized, and safe strategic flow initiatives and ensures the efficient management of major flows of traffic while minimizing the impact on other operations in collaboration with enterprise stakeholders, through real- or near-real-time resolutions informed by probabilistic decision making within established Capacity Management (CM) plans.



Efficient Trajectory Management (TM) - provides the ability to assign trajectories that minimize the frequency and complexity of aircraft conflicts through the negotiation and adjustment of individual aircraft trajectories and/or sequences when required by resource constraints.



Flexible Separation Management (SM) - provides the ability to establish and maintain safe separation minimums from other aircraft, vehicles, protected airspace, terrain and weather by predicting conflicts and identifying resolutions (e.g., course, speed, altitude, etc.) in real time. It facilitates increased capacity demands and traffic levels by using automation (e.g., DSS) while also introducing reduced separation standards into the trajectory equation.



Flexible Airport Facility and Ramp Operations - provide the ability to reallocate or reconfigure the airport facility and ramp assets to maintain acceptable levels of service that will accommodate increasing passenger and cargo demands. This includes changes in operational requirements, through infrastructure development, predictive analyses, and improvements to technology (e.g., automation and DSS) and procedures.



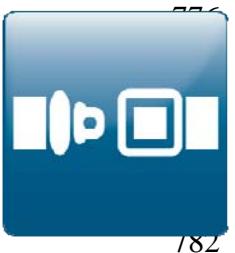
Integrated NextGen Information - provides authorized aviation stakeholders timely, accurate, and actionable information (e.g., weather, surveillance, aeronautical information, operational and planning information, and position, navigation and timing information), shortening and improving decision cycles situational awareness using a net-centric environment managed through enterprise services that meet the information exchange requirements of the NextGen stakeholder community.



Air Transportation Security - provides layered, adaptive security, based on IRM that yields the ability to identify, prioritize, and assess risks and effectively allocates resources in support of national defense and homeland security to facilitate the defeat of an evolving threat critical to the NAS infrastructure or key resources.



Improved Environmental Performance - provides the ability to proactively identify, prevent, and address environmental impacts in, the air transportation system. This is accomplished, through a CDM process, improved tools, technologies, operational policies, procedures, and practices that are consistent and compatible with national and international environmental regulations.



Improved Safety Operations - provides integrated safety management throughout the air transportation system by increased collaboration and information sharing tools, equipment, and products for stakeholders. This capability employs improved automation (e.g. DSS), technology innovations, prognostic safety risk analysis, and enhanced safety promotion and assurance techniques that are consistent and compatible with national and international regulations, standards, and procedures.

783 With these capabilities, the JPDO has an effective joint planning framework to organize the
784 significant collection of information in NextGen planning documents. This collection of
785 information will provide a coherent and compelling value proposition for the 2025 air
786 transportation system. The NextGen capabilities allow the JPDO and stakeholders to
787 communicate using common terminology and provide clear alignment between the investment
788 portfolio and the resulting value to the stakeholders and the Nation.

789 1.5 DOCUMENT SCOPE AND ORGANIZATION

790 This document, organized into the following chapters, describes the operational concepts for the
791 2025 time frame. The implementation, research, and policy issues fundamental to the
792 information contained in this document are available at www.jpdo.gov and within the Joint
793 Planning Environment (JPE) at <http://jpe.jpdo.gov>.

- 794 • **Chapter 2.** Provides a description of **Air Traffic Management Operations**, including
795 interactions among the ANSP and operators
- 796 • **Chapter 3.** Provides a detailed overview of the **Airport Operations and Infrastructure
797 Services** that address the activities surrounding the airport
- 798 • **Chapter 4.** Addresses **Net-Centric Operations** that enable enterprise services
- 799 • **Chapter 5.** Provides an initial overview of specific **Shared Situational Awareness
800 Services** that support the ATM-related concepts

- 801 • **Chapter 6.** Provides a detailed perspective of **Layered, Adaptive Security Services**
- 802 • **Chapter 7.** Describes how environmental impacts will be addressed and reduced in an
- 803 **Environmental Management Framework**
- 804 • **Chapter 8.** Addresses the **Safety Management Services**, including risk management
- 805 efforts

806 Included in the document are the following appendices, which contain supplemental information
807 for the reader:

- 808 • **Appendix A.** Provides a list of acronyms used in this document
- 809 • **Appendix B.** Provides a glossary of terms

810 Additional information on the glossary of terms and acronyms is located within the NAS/JPDO
811 Enterprise Architectures Controlled Vocabulary contained within the JPDO JPE, in addition to
812 supplemental information for the reader for all of the JPDO products.

813 This ConOps is part of the overall EA and will help formulate roadmaps and research
814 recommendations to improve overall inter-governmental collaboration to achieve national goals
815 for air transportation. This document, along with other engineering artifacts is applicable to all
816 stakeholders and provides the basis for deriving top-level requirements.

817 The JPDO will update this document periodically as research, implementation, models, policy,
818 budget realities, and other findings are assessed and as further dialogue helps refine common
819 goals and priorities. This document also serves as the official record and repository for
820 operational concept insights that emerge from the in-progress national debate on the scope,
821 characteristics, and capabilities of NextGen.

822
823

2 Air Traffic Management Operations

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825

2.1 INTRODUCTION

Air Traffic Management (ATM) is the dynamic, integrated management of air traffic and airspace—safely, economically, and efficiently—through the cost-effective provision of facilities and seamless services performed in collaboration with all parties. ATM evolves into an agile, robust, and responsive set of operations that can keep pace with the growing needs of an increasingly complex and diverse mix of air transportation system users. The three major goals, as described in the NGATS Integrated Plan, for ATM are:

- Meet the diverse operational objectives of all airspace users and accommodate a broader range of aircraft performance characteristics.
- Meet the needs of flight operators and other stakeholders for access, efficiency, and predictability in executing their operations and missions.
- Be fundamentally safe, secure, environmentally acceptable, affordable, and of sufficient capacity for both flight operators and service providers.

Today's ATM system performs well, but it is susceptible to disturbances such as weather events, and is reaching its capacity limits. The ATM system should be *scalable* enough to respond quickly and efficiently to meet growing demand and *flexible* enough to respond to changes in fleet mix, customer schedules, and operational constraints (e.g., weather).

The overall philosophy driving the delivery of ATM services is to achieve a flexible system that accommodates flight operator performance optimization when and where possible while minimizing imposed restrictions by applying them only when user actions are not sufficient to balance demand and capacity. This philosophy also includes the need to meet capacity, safety, security, and environmental constraints. In other words, the ATM system, to the maximum extent possible, adjusts airspace and other assets to satisfy forecast demand, rather than constraining demand to match available assets.

Transformation of the ATM system is necessary because of the inherent limitations of today's system, including limits driven by human cognitive processes and verbal communications. The ATM system integrates safety, capacity, security, and environmental requirements into all aspects of the system, including operations, decision support, automation, procedures, and airspace design.

To achieve the three major goals for ATM, a number of NextGen capabilities and changes in operations and services, which will change roles and responsibilities, are needed to change how ATM is performed. To assist in further achieving these ATM goals and describing the concepts, a set of capabilities has been identified to provide a framework for organizing the NextGen

858 portfolio. These capabilities represent transformational improvements to the current air
859 transportation system and various combinations of enabling solutions, such as policies,
860 programs, and systems that will make these capabilities a reality.

861 The four ATM capabilities provide:



Collaborative Capacity Management - provides the ability to dynamically balance anticipated/forecasted demand and utilization. It allocates NAS resources through proactive and collaborative strategic planning with enterprise stakeholders and automation (e.g., DSS), that consider airspace and airport design requirements, standards, and configuration conditions. This is all conducted with the consideration of other air transportation system resources.



Collaborative Flow Contingency Management - provides optimal, synchronized, and safe strategic flow initiatives and ensures the efficient management of major flows of traffic while minimizing the impact on other operations in collaboration with enterprise stakeholders, through real- or near-real-time resolutions informed by probabilistic decision making within established CM plans.



Efficient Trajectory Management (TM) - provides the ability to assign trajectories that minimize the frequency and complexity of aircraft conflicts through the negotiation and adjustment of individual aircraft trajectories and/or sequences when required by resource constraints.

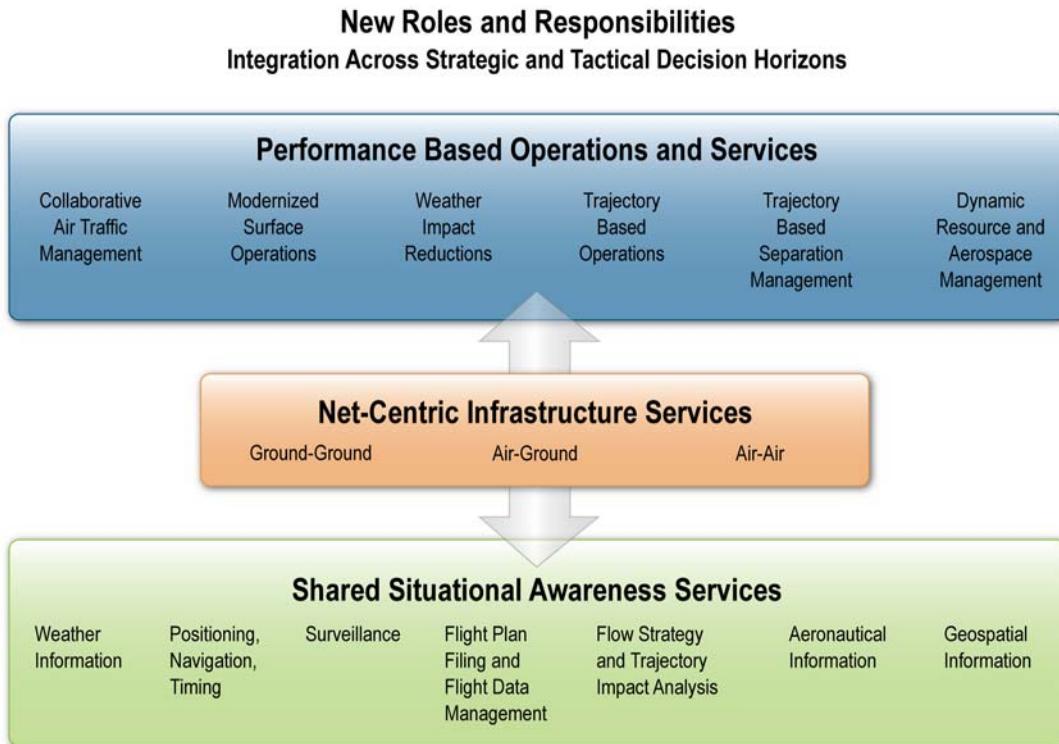


Flexible Separation Management (SM) - provides the ability to establish and maintain safe separation minimums from other aircraft, vehicles, protected airspace, terrain and weather by predicting conflicts and identifying resolutions (e.g., course, speed, altitude, etc.) in real time. It facilitates increased capacity demands and traffic levels by using automation (e.g., DSS) while also introducing reduced separation standards into the trajectory equation.

886 The ATM capabilities for collaborative capacity, flow contingency, trajectory, and separation
887 management describe at a high level vision for managing the increases in demand by maximizing
888 the use of available airspace, while increasing the safety, security, capacity, efficiency, and
889 environmental compatibility of air transportation operations. Automation is used to a greater
890 extent to manage complexity and expand the information that is available, and individual roles
891 migrate to more strategic management and decision making. As part of this shift in roles,
892 automation integrates the flight crew into ATM more, leveraging onboard aircraft capabilities to
893 achieve a scalable³ system design.

³ In this instance, scalability refers to the ATM ability to respond quickly and efficiently to increases in demand.

894

Figure 2-1 Air Traffic Management Operations and Services

895

896 Additionally, aircraft equipage would provide improvements to the ATM process and result in
897 enhancements of ANSP services. Typical aircraft equipage functionality and user benefits for
898 most aircraft would include:

- 899 • Area Navigation (RNAV)/Required Navigation Performance (RNP) and Automatic
900 Dependent Surveillance-Broadcast (ADS-B) In/Cockpit Display Traffic Information
901 (CDTI)
- 902 • Improved data communications
- 903 • Enhanced weather sensors
- 904 • Improved navigation ability (accuracy and integrity)
- 905 • Satellite-based precision instrument approach ability

906 These additional equipage functionalities provide improvements in aircraft to ANSP information
907 exchange, access, and throughput at non-towered or uncontrolled airports, and weather
908 forecasting for reduced weather impacts. Additional equipage functionalities also provide direct
909 and indirect benefits to the aircraft associated with improved overall NAS efficiency. These
910 benefits include:

- 911 • Improved controller productivity

- 912 • Improved operational efficiency in convective weather by reducing flight time
- 913 • Improved operational predictability enabled by reduced impact of disruptions
- 914 • Improved access to congested resources for more capable (or higher-performing) aircraft
- 915 • Reduced fuel usage and related costs through reduction in delay
- 916 • Optimal flight paths
- 917 • Increased flexibility for aircraft self-separation

918 **Collaborative Air Traffic Management.** With the increase and diversification in the number of
919 airspace users—each possessing a unique operating need—and the increased importance and
920 impact of other airspace uses, Collaborative Air Traffic Management (C-ATM) mechanisms
921 support a diverse set of participants. The participants share a common awareness of overall
922 constraints and the impacts of individual and system-wide decisions. Automation tools and
923 system-wide information exchange capabilities improve decision making, enabling participants
924 to understand the prevailing constraints, short- and long-term effect of decisions, and
925 interdependence among national, regional, and local operations. To manage information across
926 all phases of flight, advanced automation is utilized to make the system more agile in responding
927 to changes in environment or demand.

928 **Trajectory Based Operations (TBO).** Perhaps the most fundamental requirement is to safely
929 accommodate significantly increased traffic. Aircraft will fly negotiated trajectories allowing
930 precise management of an aircraft's current and future position, to increase throughput. This
931 trajectory prediction ability facilitates separation assurance and allows delegation responsibility
932 for separation for some operations to capable aircraft, further improving efficiency and
933 throughput. Within TBO, *high-density arrival/departure operations*, in which advanced aircraft
934 and ANSP capabilities support optimized and efficient runway throughput, accommodate peak
935 demand at the busiest airports.

936 Using 4DTs and probabilistic decision making for weather events, entire flows of aircraft as well
937 as individual trajectories can be dynamically adjusted, providing an advantage for opportunities
938 to meet constraints safely while efficiently reducing the overall impact of such events. These
939 operations replace the broad, static directives that are characteristic of today's operations.

940 Digital data exchange is the primary mode of communication between flight operators and the
941 ANSP replacing verbal delivery of clearances. Aircraft transmit and receive precise digital data
942 including aircraft routes, negotiated trajectories, and a 4DT, specifying a time and key crossing
943 point in the airspace.

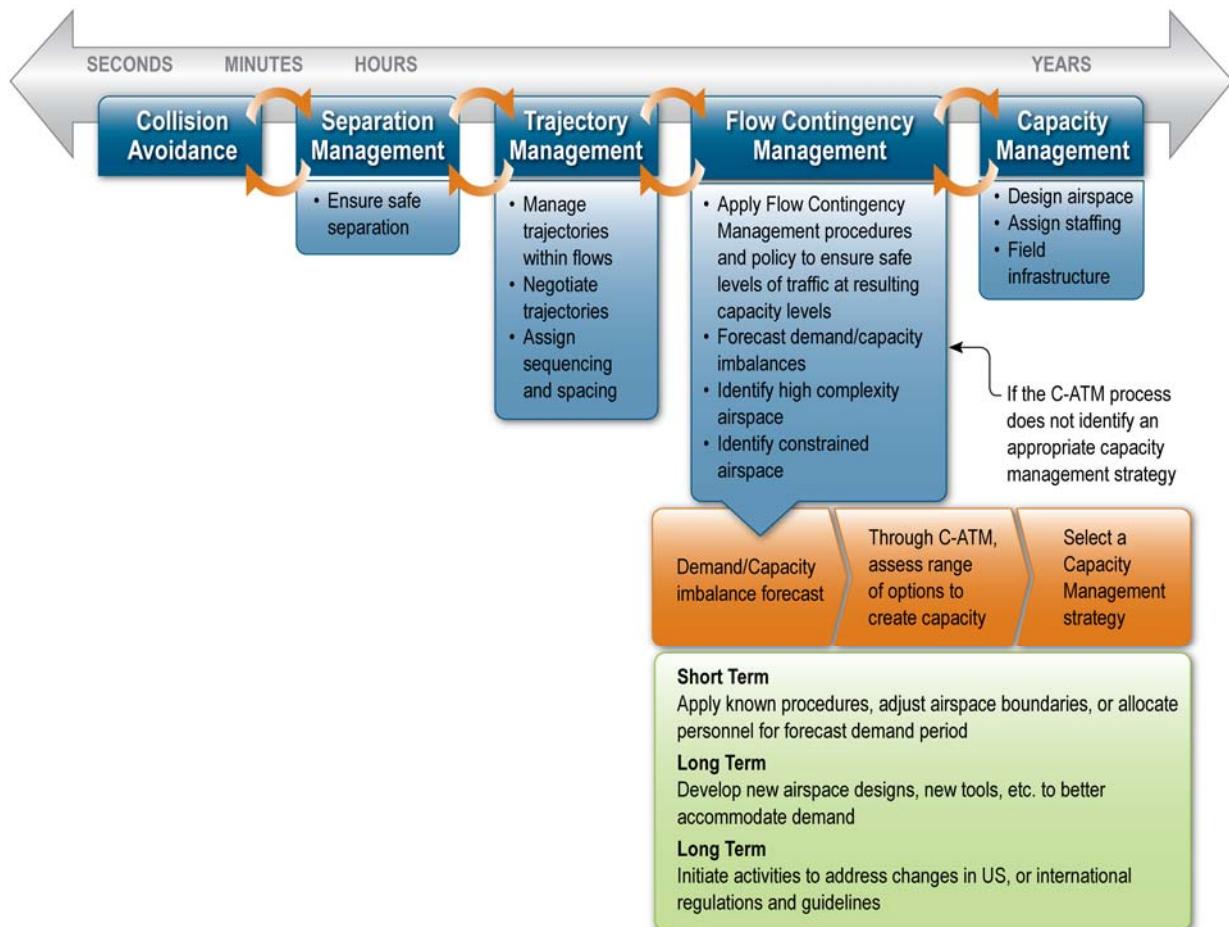
944 **ATM Service Delivery.** TBO enables the integration of trajectory planning and execution across
945 the spectrum of time horizons, from strategic planning to tactical decision making. Figure 2-2
946 describes the four ATM service delivery functions covering this spectrum. The use of real-time
947 performance measurement to assess the effectiveness, efficiency, and capacity of the system
948 against established performance metrics is an integral part of the transformation. ANSP and

949 flight operators collaboratively use the results of the analysis for integrated decision making
950 between the functions. The functions are:

- 951 • **Capacity Management (CM)** is the design and configuration of airspace and the
952 allocation of other NAS resources. CM is the preferred means of responding to dynamic
953 forecast demand—resources and performance-based services match with the expected
954 demand (Section 2.2.12.1).
- 955 • **Flow Contingency Management (FCM)** comprises strategic flow initiatives addressing
956 large demand/capacity imbalances within CM plans resulting from severe or localized
957 weather conditions and airspace restrictions. FCM ensures the efficient management of
958 major flows of traffic while minimizing the impact on other operations (Section 2.2.2).
- 959 • **Trajectory Management (TM)** is the adjustment of individual aircraft within a flow to
960 provide efficient trajectories, manage complexity, and ensure that conflicts can be safely
961 resolved (Section 2.3.1).
- 962 • **Separation Management (SM)** is the provision of safe distance between aircraft. SM
963 tactically resolves conflicts among aircraft and ensures avoidance of weather, airspace,
964 terrain, or other hazards (Section 2.3.2).

965

Figure 2-2 ATM Decisions—Interactive and Integrated Across Time Horizons



966

967 Key ATM Services Principles

968 A number of key principles are associated with the delivery of ATM services:

- 969 • Resources are managed to maximize utility to flight operators. Restrictions are imposed
970 only for projected congestion or to meet safety, security, or environmental constraints.
- 971 • Support a range of operator goals and business models to not inherently favor one
972 business model over another; however, public policy may provide incentives for one or
973 more business models, if desired.
- 974 • Stakeholders maximize their ability to achieve their goals and business objectives by
975 actively participating in the C-ATM process. This involves not only information
976 exchange and negotiation with respect to flight trajectories, but also involvement in the
977 process of allocating ATM resources. Tools are in place to allow virtually any operator to
978 participate in the C-ATM process.

- 979 • When performance-based operations and C-ATM cannot address excess demand, known
980 policies will prioritize access to resources among all operators.
- 981 • Access to NAS resources considers all national objectives. For example, military, state,
982 and civil aircraft that are involved in national security, homeland defense, disaster
983 response, public safety, life-guarding actions, and movement of high-ranking government
984 officials receive appropriate priority.
- 985 • Airspace is a national resource, used for the “public good.” Government mandates are an
986 acceptable means of meeting “public good” objectives when incentives are insufficient.

987 Key ATM Services Assumptions

988 Key assumptions for the ATM system and services include the following:

- 989 • *Performance-based operations* are the basis for defining requirements. In particular,
990 Communication, Navigation, and Surveillance (CNS) performance becomes the basis for
991 operational approval, rather than specific equipage or technologies. Performance-based
992 operations simplify regulatory activities in the presence of technology proliferation and
993 allow the opportunity to define “pre-approved” operations based on performance levels.
- 994 • The ANSP provides performance-based services, allowing operational benefits to aircraft
995 that have advanced capabilities. For a given airspace volume, the minimum level of
996 ability may vary depending on the environment and overall demand characteristics. Flight
997 operators choose ability levels for their aircraft according to their needs and to make the
998 economic tradeoff between level of service and aircraft investment.
- 999 • Network-enabled services provide a broad ability to move, store, and access information.
1000 All stakeholders have a consistent view of factors that affect their decision making, while
1001 data security and privacy mechanisms ensure that information is not misused or
1002 inappropriately disclosed.
- 1003 • Advanced automation performs routine tasks and supports distributed decision making
1004 between flight operators and the ANSP. New automation systems and procedures are in
1005 use by both aircraft and the ANSP, enabling TBO and other transformations critical to
1006 achieving NextGen objectives.
- 1007 • There is a wider range of aircraft capabilities and performance levels than exists today.
- 1008 • Environmental outcomes are increasingly important in designing and conducting ATM
1009 operations.
- 1010 • International interoperability in performance-based operations is a requirement as
1011 capabilities and procedures are defined.

1012 **Dynamic Resource Management.** The move toward dynamic resource management supports
1013 the need to provide improved services to all users. ATM system resources and services are
1014 delivered to meet demand, rather than constraining demand to match the available resources
1015 (including people, facilities, and airspace). Delivery of services is no longer tied directly to the

1016 geographic location of the aircraft. ANSP personnel acquire needed information and
1017 communicate with flight operators independent of their facility location.

1018 **Weather Impact Reductions.** The impact of weather is reduced through the use of improved
1019 information sharing, new technology to sense and mitigate the impacts of weather, improved
1020 weather forecasts, and improved decision making through the integration of weather into
1021 automation. Using better automation to manage uncertainties associated with weather will
1022 minimize airspace capacity limitations and reduce the likelihood of overly conservative actions.

1023 Key aircraft flight deck advancements that may improve airport accessibility include aircraft-
1024 based technologies such as Head-Up Display (HUD), or auto-land capabilities, Enhanced Flight
1025 Vision Systems (EFVS), and Synthetic Vision Systems (SVS), Sense and Avoid, as well as the
1026 ground-based augmentation system (GBAS) in combination with a Global Navigation Satellite
1027 System (GNSS). These new aircraft flight technologies will allow greater access and throughput
1028 at airports that would otherwise be unavailable due to insufficient ground infrastructure. By
1029 equipping with technologies such as HUDs or EFVS, the aircraft operator will have greater
1030 flexibility and predictability of operations at a variety of airports with less dependence on
1031 existing ground infrastructure.

1032 **Modernized Surface Operations.** Finally, another transformation in ATM is the advent of
1033 modernized surface operations. Surface operations move from a highly visual, tactical
1034 environment to a more strategic set of operations enabled by enhanced or synthetic vision in
1035 low/no-visibility conditions that will better achieve operator and ANSP efficiency objectives,
1036 and better integrate surface, airspace, and traffic flow decision making. Modernized surface
1037 operations delivers surface and tower services more affordably, enabling access to ANSP
1038 services at more airports than is practical today, resulting in greater value to flight operators and
1039 airport operators.

1040 2.2 COLLABORATIVE AIR TRAFFIC MANAGEMENT

1041 All airspace users are able to collaborate on ATM decisions. This ability ranges from today's
1042 large-scale FOCs with a complete set of C-ATM automation tools to individual pilots with
1043 mobile devices, personal computers or onboard the aircraft for appropriately scaled C-ATM
1044 collaboration access. Those who participate in the collaboration process are better able to achieve
1045 their own objectives within the constraints imposed by overall traffic demand or short-term
1046 effects such as weather or airspace restrictions.

1047 Collaboration involves the exchange of information to create mutual understanding of overall
1048 objectives among participants and to share decision making among stakeholders. With the
1049 collaborative capabilities, stakeholders are aware of constraints, system strategies, and the
1050 performance metrics that describe the past and predicted behavior of the ATM system. The
1051 service provider is aware of stakeholder route preferences, performance capabilities, and flight-
1052 specific performance limitations. Key stakeholders in ATM decision making include the ANSP,
1053 flight operators (including both flight planners and flight crews), airport operators and regional
1054 authorities, security providers, and U.S. military and state organizations. These groups and others
1055 collaborate in developing and assessing strategies to expand NAS capacity, addressing short-

1056 term demand and capacity imbalances, efficiently managing Special Activity Airspace (SAA),
1057 and coordinating appropriate responses to address security needs.

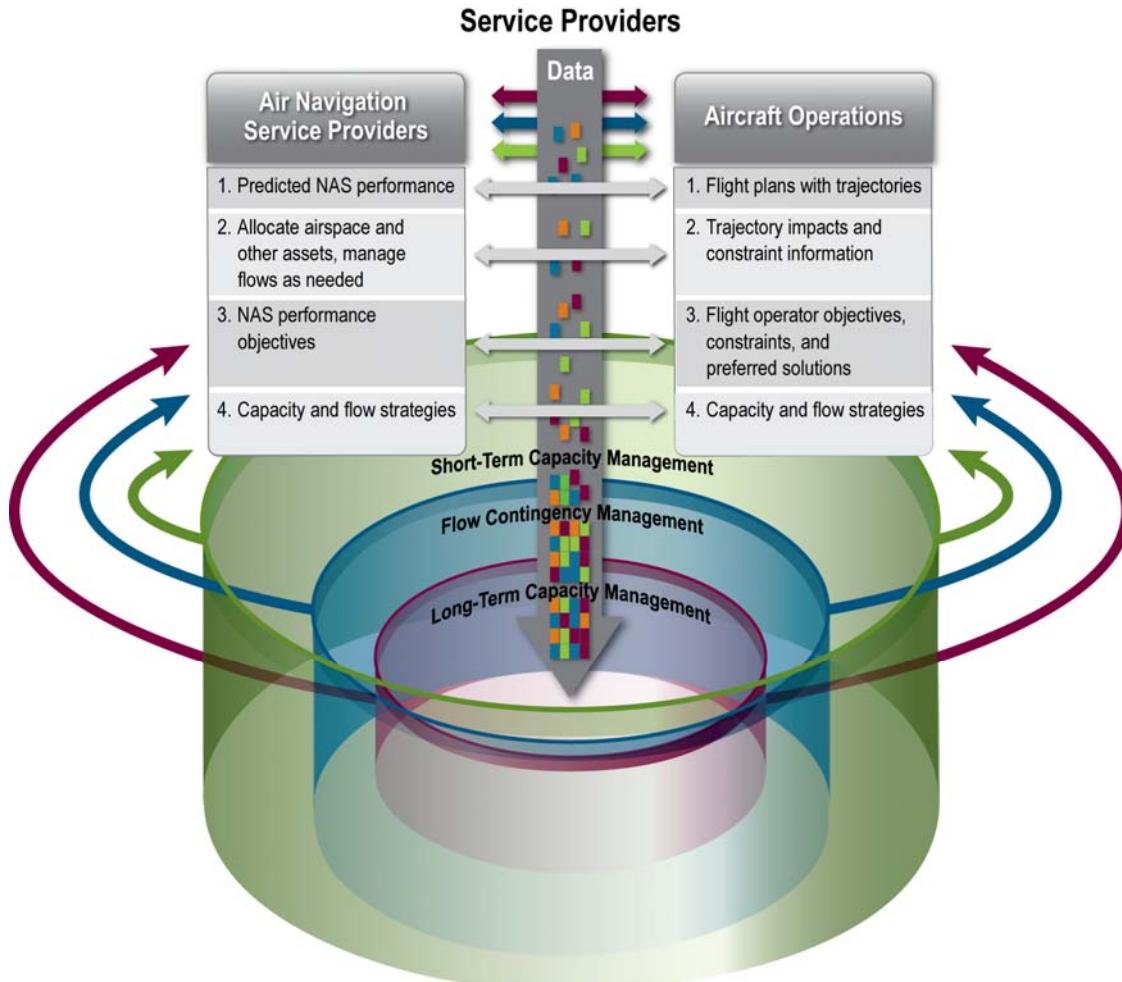
1058 Key benefits from the collaborative environment include the following:

- 1059 • Airspace users benefit from improved collaborative Decision Support Tools (DST),
1060 which better assess the potential impacts of decisions, reducing the likelihood of
1061 unintended consequences. Improved DSTs also increase the system's ability to maintain
1062 capacity and increase predictability in the presence of continuous uncertainty. Less
1063 conservative operational decisions are made because decision support capabilities can
1064 better integrate large amounts of data over multiple time horizons.
- 1065 • Today's collaboration process is characterized by poor information distribution and is
1066 limited by verbal negotiations. The future system will be characterized by increased
1067 participation wherein flight operators gain benefits in efficiency, access, and overall
1068 performance and other national needs are accommodated effectively.
- 1069 • Information exchange is more clearly targeted to the appropriate decision makers,
1070 reducing workload and unnecessary actions by those not affected. Machine-to-machine
1071 negotiation replaces labor-intensive, voice, or text-based processes.
- 1072 • Needs for managing airspace security are integrated into overall collaboration and
1073 decision making.
- 1074 • Participants are assured of data privacy and protection, so that sensitive or proprietary
1075 information can be utilized in a way that helps to achieve their objectives.
- 1076 • By participating in the collaborative process and providing user preferences, the airspace
1077 users benefit from flying their desired routes based on their business need.

1078 C-ATM is the means by which flight operator objectives are balanced with overall NAS
1079 performance objectives and accomplishes many of the objectives for CM, FCM, and TM. Flight
1080 planners or an operator's flight planning automation interact with the ANSP via a set of services
1081 that provide all stakeholders with the opportunity to participate in the C-ATM process. Among
1082 these services is a common flow strategy and trajectory analysis service that enables Shared
1083 Situational Awareness (SSA) of current and projected NAS status and constraints. This service
1084 provides stakeholders with the ability to examine the individual or aggregate impacts of
1085 proposed strategies for CM or FCM.

1086 With information sharing, flight operators and the ANSP have a common understanding of
1087 overall national goals and desired performance objectives for the NAS. A transparent set of
1088 strategies is in place to achieve overall performance objectives, including airspace management
1089 to maximize capacity when demand is high and, as required, flow management initiatives to
1090 ensure that safe levels of traffic are not exceeded when capacity limits are reached. The ANSP is
1091 better able to communicate and collaborate on the effects of procedures for flights transiting
1092 airspaces managed by different ANSP entities (e.g., for different Flight Information Regions
1093 [FIRs], for specially managed SAA). Figure 2-3 provides a pictorial view of C-ATM.

1094

Figure 2-3 Collaborative ATM among the ANSP and Operators

1095

1096 The rest of this section provides greater depth on the C-ATM process. Section 2.2.1 describes the
1097 CM process. Section 2.2.2 describes the FCM process. FCM is used only when CM cannot fully
1098 adjust resources to match anticipated demand.

1099 **2.2.1 Capacity Management**

1100 CM has two components, short term and long term. “Short-term” CM is the reallocation of assets
1101 and the use of procedures to maximize capacity to match anticipated demand. In contrast, “long-
1102 term” CM includes planning for major changes to airspace design, significant airport
1103 infrastructure improvements, and the establishment of new operational procedures. The CM
1104 process allocates NAS resources to meet overall system goals based on user plans, including the
1105 designation of airspace (e.g., for performance requirements) and the determination of procedures
1106 required for access to airspace. CM structures routings, where required, to manage complexity
1107 and reserves airspace, as needed, for special uses. CM responds to an aggregation of airspace
1108 users’ expected or desired trajectories, infrastructure, geographic, and environmental constraints,
1109 and it provides airspace assignments and dynamic routings to manage the resulting demand.

1110 The CM process begins years before flights are in operation and continues up to and including
1111 the day of operation. It includes the long-term and short-term management and assignment of
1112 NAS airspace and trajectories to meet expected demand, assignments of related NAS assets, and
1113 coordination of long-term staffing plans for the airspace assignments. Significant structural
1114 changes to airspace or operations (e.g., building a new runway or introducing a new flight
1115 procedure) are planned years in advance. The best usable solutions selected are through iterative
1116 collaboration across decision horizons.

1117 **2.2.1.1 Short-Term Capacity Management**

1118 Short-term CM involves the allocation of existing assets (e.g., allocation of personnel,
1119 adjustment of airspace structures, or designation of performance-based services) to appropriately
1120 create the required capacity to meet anticipated demand. Resource management is flexible and
1121 dynamic, which enables the ATM system to apply people where their services are most needed,
1122 to manage and configure facilities appropriately, and to designate the use and design of airspace
1123 to complement operations. Delivery of services is no longer tied directly to the geographic
1124 location of the flight operator or the aircraft; instead, ANSP personnel have the ability to acquire
1125 needed information and communicate with flight operators independent of their facility location.

1126 As operators plan flights, they share information with the ANSP about the planned trajectory of
1127 the aircraft. These trajectories may have different levels of precision based on the expected
1128 operations to be performed. For TBO, the operator's flight plan includes a 4DT. As more
1129 information about the conditions affecting a flight becomes available, operators are automatically
1130 informed and in turn, update their flight plans to provide current and intent information. In
1131 general, operators use predefined routes less and have more flexibility in designating preferred
1132 routings. Some route structures remain, where needed, to manage complexity, especially at lower
1133 altitudes and in terminal airspace where ANSP personnel require more knowledge about the
1134 airspace, and where environmental restrictions exist. Airspace designated for high-capacity or
1135 high-complexity operations may hold a specific designation for a certain set of hours in the day
1136 or over a set period of days. This dynamic use of airspace is complemented with the move
1137 toward performance-based services that specify minimum performance criteria that an aircraft is
1138 required to meet for operating in a volume of airspace. Further, this dynamic nature is
1139 transparent, allowing flight operators the ability to plan and execute their flights.

1140 CM and FCM functions are interactive, as are airspace and TM functions. The demand-capacity
1141 balancing process determines which CM strategies to employ across the NAS. Part of the CM
1142 process also includes the use of metrics and analyses to determine which strategies were most
1143 effective under which conditions. Examples of CM strategies include the following:

- 1144 • Increasing the capacity of a given area of airspace to accommodate projected traffic
1145 growth through reassignment of resources (e.g., personnel, RNP routes).
- 1146 • Instituting structured routes to reduce traffic complexity.
- 1147 • Establishing flow corridors to better accommodate high levels of traffic.
- 1148 • Adjusting the boundaries or activation times of SAA.
- 1149 • Balancing workload among ANSP personnel for a forecast demand “surge”.

1150 An important area of short-term collaboration for CM is in addressing the use of SAA and
1151 assessing the impacts of proposed SAA use. For example, the military operator will reserve the
1152 airspace and then activate it upon commencing operations with the ANSP (possibly pilot-to-
1153 controller). Depending upon the required operations, the ANSP with the operator's concurrence
1154 could adjust boundaries and activation times to maximize civil use of the airspace when it is not
1155 being used. For instance, if a pilot is only using a small section of a military operations area, they
1156 might be willing to open up the rest of the airspace to civil uses. The military and the ANSP will
1157 define the appropriate criteria for this process.

1158 Collaboration among the ANSP, flight operators, defense services providers, and security
1159 services providers is critical in determining effective use of airspace for security and defense
1160 needs. A default strategy of static restrictions is no longer used to address security needs.
1161 Instead, management of security and defense needs is based on flight-specific access
1162 requirements where practical (also see Chapter 6.3.5 for secure airspace concepts). The overall
1163 goal for airspace collaboration is to recognize national defense and security needs and to
1164 minimize disruption of air traffic. This is done by dynamically and efficiently assessing airspace
1165 needs and adjusting as needed in order to ensure the military's requirements, such as live firing
1166 ranges, pilot training, security of sensitive assets, etc. are met. Flight operators receive this
1167 information, so they can better plan flights and be aware of likely restrictions.

1168 Both defense and homeland security restrictions are dynamically managed to enhance airspace
1169 access. When airspace restrictions are proposed to address security concerns, the impacts of a
1170 proposed restriction are weighed against identified risks, and mitigations are identified to reduce
1171 the impact on flight operator plans. The philosophy in applying airspace restrictions is to ensure
1172 national defense needs are met while providing maximum available airspace to other users via
1173 priority 4DT reservations, and facilitating immediate user notification of "just-in-time" national
1174 needs for restricted airspace. In addition to improved SSA and automated conformance
1175 monitoring, management of security and defense needs evolve, wherever possible, toward flight-
1176 specific access requirements and away from blanket restrictions for airspace access.

1177 **2.2.1.2 Long-Term Capacity Management**

1178 Long-term CM generally requires months to several years to implement, depending on the
1179 solution set (e.g., build a new runway, or develop a new automation system). CM solutions
1180 requiring the development of new operational procedures, design of airspace, or implementation
1181 of a new technology require the ANSP to perform pre-implementation activities including R&D,
1182 environmental impact assessment and mitigation, and safety and security analysis. The solutions
1183 typically also involve external collaboration with manufacturers, flight operators, regulators, or
1184 other stakeholders. As proposed changes are defined, the ANSP addresses U.S. or international
1185 regulatory and policy bodies in a more effective and streamlined manner than is possible today.

1186 **2.2.2 Flow Contingency Management**

1187 FCM is the process that identifies and resolves congestion or complexity resulting from blocked
1188 or constrained airspace or other off-nominal conditions. FCM deals with demand-capacity
1189 imbalances that cannot be addressed through the CM process. FCM involves managing the
1190 conflicting objectives of multiple stakeholders, regarding the operational use of over-subscribed

1191 airspace and airports, while taking advantage of available capacity to address demand. The
1192 collaborative process among flow contingency managers, flight operators, and airport operators
1193 allows flight operators to find solutions that best meet their priorities and constraints while
1194 satisfying the conditions specified in a given FCM plan.

1195 Several guiding principles govern the concept of FCM:

- 1196 • FCM addresses multiple types of constraints, including airspace, airport, and metroplex
1197 constraints.
- 1198 • FCM becomes more agile in dealing with uncertainties, developing adaptive traffic
1199 management plans that use capacity as it becomes available, and safely dealing with
1200 scenarios that become more constrained than expected.
- 1201 • FCM provides equitable treatment of flight operators and, as much as possible, gives
1202 them the flexibility to meet their objectives.
- 1203 • FCM becomes more focused, affecting only those flights necessary to deal with a
1204 constraint.

1205 FCM strategies can include establishing multiple trajectories and/or flow corridors to reduce
1206 complexity (Section 2.2.2), restructuring the airspace to provide more system capacity, or
1207 allocating time-of-arrival and departure slots to runways or airspace. Operators with multiple
1208 aircraft involved in an initiative have the flexibility to adjust individual aircraft schedules and
1209 trajectories, within those allocations, to accommodate their own internal priorities. The ability
1210 for automation to monitor conditions and identify new trends facilitates dynamic refinement of
1211 Traffic Management Initiatives (TMI) and reduces the likelihood that TMIs are overly
1212 conservative in managing the NAS. Various FCM functions and activities may occur months or
1213 days in advance of a flight or during a flight. As with all TMIs, probabilistic decision making is
1214 used to assess the likely regional and local effects of anticipated flows, weather patterns, and
1215 other potential constraints and take incremental actions to reduce the probability of congestion to
1216 acceptable levels without overprotecting NAS resources.

1217 FCM may also be achieved by integrating the aircraft's navigation ability with data link. The
1218 precision and reliability of RNP routes, for example, can also be applied to dynamically defined
1219 routes to enhance user access and ATM. Many current aircraft have some functionality (e.g.,
1220 Future Air Navigation System [FANS-1A]) to negotiate a trajectory. A negotiated trajectory may
1221 be as simple as an expected path from top-of-descent or as complex as a 4DT path.

1222 **2.3 TRAJECTORY-BASED OPERATIONS**

1223 Currently, controllers manage separation by using radar screens to visualize trajectories and to
1224 make cognitive operational judgments, with some automation decision support to help identify
1225 and resolve conflicts. TBO are used as the mechanism for managing traffic. TBO utilize 4DTs
1226 as the basis for planning and executing all flight operations supported by the ANSP. The
1227 traditional roles and responsibilities of pilots/controllers based upon verbal and route based
1228 clearances will evolve through the use of digital data exchange due to the increase in automation,
1229 support, and integration inherent to TM.

1230 The use of TBO as the main mechanism for managing traffic in high-density or high-complexity
1231 airspace is a major transformation. TBO represents a shift from clearance-based to trajectory-
1232 based control. Aircraft will fly open and closed negotiated trajectories as ATC moves to TM.
1233 With a closed trajectory, automation between the ANSP and the aircraft is synchronized. An
1234 aircraft may be permitted to fly an open trajectory as needed to maneuver for weather avoidance,
1235 a vector, Visual Flight Rule (VFR) operations, etc. To the maximum extent possible, an aircraft
1236 on an Instrument Flight Rules (IFR) flight plan will maintain its closed trajectory. If the aircraft
1237 is unable to maintain performance requirements, then a controller would be able to intercede to
1238 update the aircraft's trajectory. Overall, controllers will manage flows of traffic rather than
1239 individual aircraft. The traditional responsibilities and practices of pilots/controllers will evolve
1240 due to the increase in automation, support, and integration inherent to TM.

1241 In high-density or high-complexity airspace, TBO aligns all TM functions across all time
1242 horizons based upon the aircraft's 4DT. Digital data communication and ground-based and
1243 airborne automation to create, exchange, and execute 4DTs are prerequisites for TBOs. The use
1244 of precise 4DTs dramatically reduces the uncertainty of an aircraft's future flight path, in terms
1245 of predicted spatial position (latitude, longitude, and altitude) and times along points in its path.
1246 This enables airspace to be used much more effectively than is possible today to safely
1247 accommodate high levels of demand and maximize the use of capacity-limited airspace and
1248 airport resources. TBO and high-density arrival/departure operations are likely to be used during
1249 peak periods at the busiest metropolitan areas. High-altitude en route and oceanic airspace, and
1250 areas where major flows occur, also use TBO. With TBO, less airspace is needed for these major
1251 flows, resulting in reduced impact and improved access for other flights.

1252 With TBO, differing types of operations are conducted, distinguished by the manner in which
1253 procedures are selected and clearances are initiated, transmitted, negotiated, monitored, and
1254 revised. Performance-based services are applied based on the anticipated traffic characteristics;
1255 minimum requirements for operations and procedures to be used are selected to achieve the
1256 necessary level of capacity. Overall, preferences for all users are accommodated to the greatest
1257 extent possible, and trajectories are constrained only to the extent required to accommodate
1258 demand or other national concerns, such as safety, security, or environmental concerns. With
1259 TBO, the ANSP provides services to aircraft of differing ability in proximity to each other.
1260 Operators that equip their fleets to conduct TBO receive services from the ANSP that allow them
1261 to achieve operating benefits.

1262 Trajectory-based SM is a major element of TBO. SM uses automation and shared trajectory
1263 information to manage separation among aircraft, airspace, and hazards such as weather and
1264 terrain better. Trajectory-based SM may also include delegation of separation tasks to the flight
1265 crew. Improved information sharing, improved sensors and forecasting, and better integration of
1266 weather into automated DSTs help reduce the impact of weather on the entire system. Finally,
1267 the ATM framework builds on surface operations that are modernized and better integrated into
1268 airspace operations to achieve efficiencies not possible today. A number of capacity, efficiency,
1269 and general benefits have resulted from the increased predictability of operations, which is based
1270 on use of precise trajectories. These benefits include safety and increased ANSP productivity.
1271 Benefits from the use of TBO include the following:

- **Capacity/Better Airspace and Runway Utilization.** One of the primary uses of TBO is to increase the inherent capacity of airspace to better accommodate demand from flight operators. As a result, TBO and trajectory-based planning, together with improved weather information integrated into decision making and integration of military, security, environmental, and other requirements, allow access to more airspace more of the time, with reduced impact to traffic flows. The flexible management of aggregate trajectories enabled by TBO allows the ANSP to maximize access for all traffic, while adhering to the principle of giving advantage to those aircraft with advanced capabilities that support the ATM system. TBO minimizes excess separation resulting from today's control imprecision and lack of predictability and enables reduced separation among aircraft, allowing increased capacity. TBO is also a key element of high-density arrival/departure procedures. Implementing these procedures enables new runways to be built much closer to existing runways and potentially reduces the cost of new runway construction.
- **Efficiency and Environment.** Operational management of TBO (via an aircraft's 4DT) enables efficient control and spacing of individual flights, especially in congested arrival/departure airspace and busy runways. This enables use of noise-sensitive and/or reduced-emissions arrival/ departure flight paths. For long flights, particularly in oceanic airspace, the increased predictability afforded by TBO improves fuel efficiency and facilitates optimal fuel loading. Overall, flight operations are more consistent and operators are able to maintain schedule integrity without the excess built into today's published flight times.
- **Other Benefits.** In addition to supporting increased flows, TBO enables collaboration between the ANSP and operators to maximize utility of airspace to meet ANSP productivity and operator goals. TBO also allows for scalability of the entire system, as operators become more active in collaborations with the ANSP to manage their own trajectories. Finally, TBO is seen as a key enabler to increase ANSP productivity, so services can be provided at a much lower per-operation cost.

2.3.1 Trajectory Management (TM) Process

TM is the process by which individual aircraft trajectories are managed just before and during the flight to ensure efficient individual trajectories within a flow. TM corrects imbalances within an established flow to ensure that congestion is manageable. The TM process considers any active FCM initiatives and known airspace plans in establishing the best mitigation to resource contention. TM assigns trajectories for aircraft transitioning out of self-separation operations and for aircraft entering or leaving flow corridors. For arrival/departure operations, including high-density operations, TM assigns each arriving aircraft to an appropriate runway, arrival stream, and place in sequence. TM supports SM by reducing, but not eliminating, the need for tactical separation maneuvers.

2.3.2 Separation Management Process

The SM process ensures that aircraft maintain safe separation from other aircraft, from certain designated airspace, and from any hazards (e.g., terrain, weather, or obstructions). SM relies significantly on automation for predicting conflicts and identifying solutions. Use of automation also allows SM to move away from fixed human-based standards to ones that allow variable

1314 separations that factor in aircraft capabilities, encounter geometries, and environmental
1315 conditions. Flight crews approve the recommended conflict resolution before it is implemented,
1316 whether it is generated on the ground or in the cockpit.

1317 In managed airspace, the ANSP has overall responsibility for SM and may delegate this
1318 responsibility to separation-capable aircraft. The operating norm is that the ANSP delegates tasks
1319 to aircraft to take advantage of aircraft capabilities. ANSP automation manages separation and
1320 negotiates short-term, conflict-driven updates to the 4DT agreements with the aircraft. Delegated
1321 separation operations include both a single aircraft with separation authority for a specific
1322 maneuver (e.g., for crossing or passing another aircraft) or more general separation
1323 responsibility, such as operating in flow corridors (Section 2.3.3.2). ANSP and aircraft
1324 automation track the delegation of responsibility and its limits and ensure that the delegation is
1325 always unambiguous.

1326 Aircraft performing self-separation procedures separate themselves from one another as well as
1327 from aircraft whose separation is managed by the ANSP without intervention by the ANSP. The
1328 ANSP provides neither separation nor TM services in self-separation airspace, but the aircraft
1329 may still be subject to TM in downstream transition airspace. Standardized algorithms detect and
1330 provide resolutions to conflicts at least several minutes ahead of the predicted loss of separation.
1331 The resolution maneuver is usually very small (because of the increased precision in TBO) and
1332 generally includes course, speed, or altitude changes. Rigorous right-of-way rules determine
1333 which aircraft should maneuver to maintain separation when a conflict is predicted. These rules
1334 specify the conflict resolution maneuver options for resolving the conflict with minimum
1335 disruption to the maneuvering aircraft and for preventing a conflict with a third aircraft in the
1336 short term. Contingency procedures, requiring the other aircraft to execute an avoidance
1337 maneuver, are invoked in the event the “burdened” aircraft does not make the appropriate
1338 maneuver within a specified time.

1339 Self-separating aircraft have 4DTs with sufficient flexibility defined to allow for separation
1340 maneuvers. After such maneuvers, the aircraft is expected to return to its route toward its next
1341 waypoint defined in the 4DT or negotiate a new 4DT. Usually the aircraft is able to achieve and
1342 maintain its most efficient trajectory without renegotiating its 4DT. In oceanic or remote
1343 airspace, the aircraft may have sufficient flexibility to deviate around weather. A FCM function
1344 may be needed in self-separation airspace to impose sufficient structure to ensure that traffic
1345 density remains safe, especially around convective weather or other constraints.

1346 Transition airspace around self-separation airspace exists to allow for the safe transfer of
1347 separation responsibility from the aircraft back to the ANSP. For aircraft entering self-separation
1348 airspace, separation responsibility is transferred so that the aircraft is safely able to assume it,
1349 implying that there are no very near-term conflicts with other aircraft or hazards. For aircraft
1350 exiting self-separation operations, the transition may include waypoints with Controlled Time of
1351 Arrivals (CTA) to enable sequencing and scheduling by the ANSP. In this transition zone, the
1352 ANSP provides CTAs and possibly TM to maintain safe separation between the aircraft exiting
1353 the airspace. As with delegated separation, the ANSP and aircraft automation track the transfer
1354 of separation responsibility and communicate it to those affected.

1355 Today, most high-performance aircraft are equipped with an aircraft-based collision avoidance
1356 system that is independent of the ATC system. In the United States, this system is referred to as
1357 the Traffic Alert and Collision Avoidance System (TCAS) II. Internationally, this system is
1358 referred to as the Airborne Collision Avoidance System (ACAS). TCAS II reduces the risk of
1359 collision between aircraft when the separation assurance process fails. A collision avoidance
1360 system independent of the separation assurance system, and which acts only in the event the
1361 separation assurance process fails, will still be required (see ICAO AN-Conf/11, ASAS
1362 Circular).

1363 **2.3.3 TBO Aircraft Procedures**

1364 The procedures performed by 4DT-capable aircraft are described in this section. The procedures
1365 used most include:

- 1366 • **4DT Procedures.** In addition to basic RNP ability, aircraft must meet specified timing
1367 constraints at designated waypoints along their route. Aircraft comply with the resulting
1368 4DT procedure in flight. Several levels of 4DT operations exist, defined by the level of
1369 navigational and timing constraints.
- 1370 • **Delegated Separation Procedures.** The ANSP delegates responsibility to capable
1371 aircraft, performing the basic 4DT procedures described above, to perform specific
1372 separation operations using onboard displays and automation support. Examples include
1373 passing, crossing, climbing, descending, and turning behind another aircraft. In these
1374 operations, the ANSP is responsible for separation from all other traffic while the designated
1375 aircraft performs the specific maneuver.
- 1376 • **Airborne Merging and Spacing Procedures.** 4DT aircraft are instructed to achieve and
1377 maintain a given spacing, in time or distance, from a designated lead aircraft as defined
1378 by an ANSP clearance. Cockpit displays and automation support the aircraft conducting
1379 the merging and spacing procedure to enable accurate adherence to the required spacing.
1380 Separation responsibility remains with the ANSP.
- 1381 • **Airborne Self-Separation Procedures.** Aircraft are required to maintain separation from
1382 all other cooperative aircraft (and other obstacles or hazards) in the airspace. Aircraft
1383 follow the “rules of the road” and avoid any maneuvers that generate immediate conflicts
1384 with any other aircraft. The ANSP does not provide TM or SM, except as needed to
1385 safely sequence and schedule aircraft exiting self-separation airspace.
- 1386 • **Low-Visibility Approach/Departure Procedures.** Aircraft with appropriate cockpit
1387 displays and automation support conduct landings and takeoffs safely in low-visibility
1388 conditions without relying on ground-based infrastructure by using onboard navigation,
1389 sensing, and display capabilities.
- 1390 • **High-density Arrival/Departure Procedures.** Aircraft conduct delegated separation
1391 procedures, such as Closely Spaced Parallel Approaches (CSPA), within very precise
1392 tolerances for position and timing to maximize runway throughput.
- 1393 • **Surface Procedures.** Trajectory-based procedures may be used on the airport surface, at
1394 high-density airports, to expedite traffic and schedule active runway crossings. Equipped

1395 aircraft may perform delegated separation procedures, especially in low-visibility
1396 conditions.

1397 The procedures listed above are not mutually exclusive, and the flight object captures the
1398 abilities and authority of aircraft to perform these procedures.

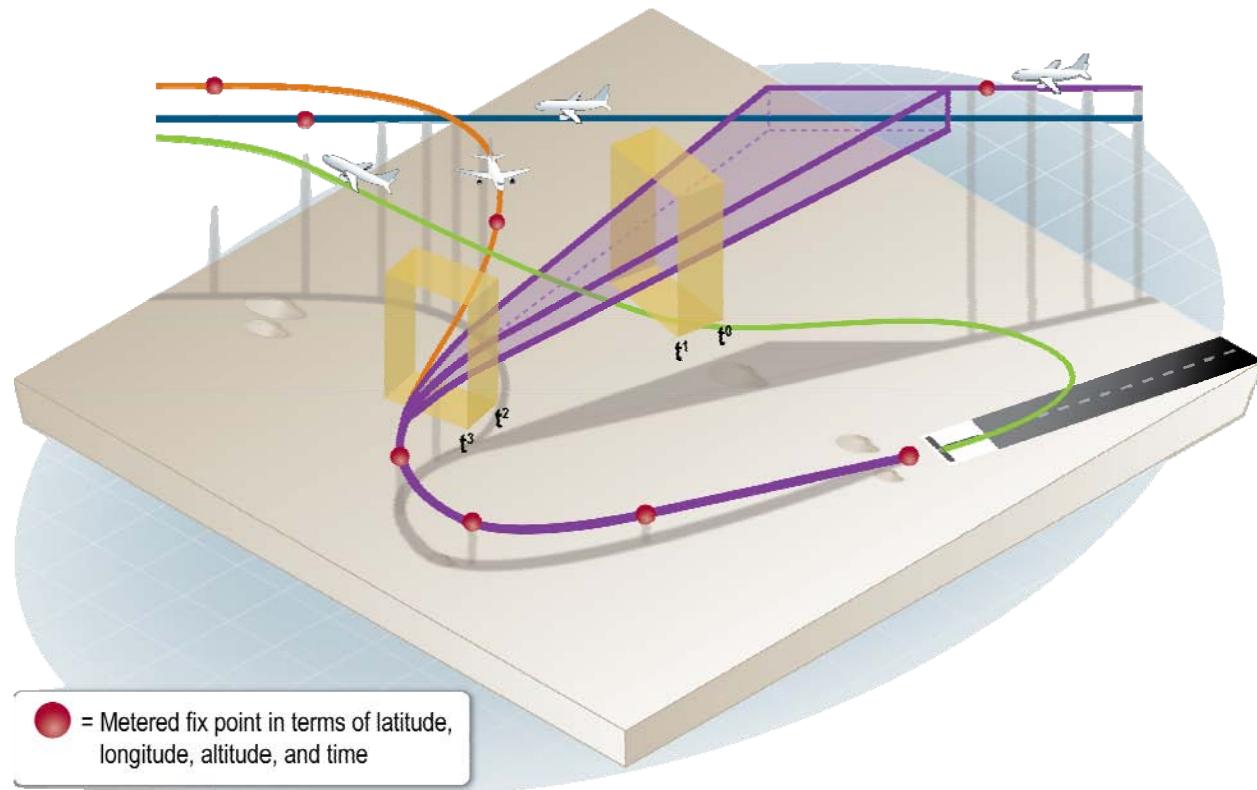
1399 **2.3.3.1 Four-Dimensional Trajectories**

1400 A 4DT is a precise description of an aircraft path in time and space: the “centerline” of a path
1401 plus the position uncertainty, using waypoints to describe specific steps along the path (See
1402 Figure 2-4). This path is Earth-referenced (i.e., specifying latitude and longitude); containing
1403 altitude descriptions and the time(s) the trajectory will be executed. The required level of
1404 specificity of the 4DT depends on the flight operating environment. Information regarding the
1405 operator’s flight plan is managed as part of the flight object.⁴ The flight object provides access to
1406 all relevant information about a particular flight.

1407 Some of the waypoints in a 4DT path may be associated with CTAs. CTAs are time “windows”
1408 for the aircraft to cross specific waypoints within a prescribed conformance tolerance and are
1409 used when needed to regulate traffic flows. Both the flight crew and the ANSP may need to
1410 renegotiate CTAs during the flight for reasons such as winds encountered that are different from
1411 forecast or a change in the destination airport acceptance rate. Larger windows in time are
1412 allotted to cross all other waypoints not designated as CTAs, allowing operators more flexibility
1413 to optimize their flight operations.

⁴ The flight object is a software representation of the relevant information about a particular flight. The information in a flight object includes aircraft identity, CNS and related capabilities, flight performance parameters, flight crew capabilities including for separation procedures, and the flight plan (which may or may not be a 4DT), together with any alternatives being considered. [R-7] Once a flight is being executed, the flight plan in the flight object includes the “cleared” flight profile, plus any desired or proposed changes to the profile, and current aircraft position and near-term intent information (See Figure 2-6). For Visual Flight Rules (VFR) aircraft, the level of detail on the flight profile varies (e.g., it may consist of only information needed for Search and Rescue [SAR] operations). Allocation of responsibility for separation management along flight segments is also likely to be stored. International collaboration on the development of standards for the definition of a flight object is ongoing.

1414

Figure 2-4 Four-Dimensional Trajectory

1415

1416 The integration of trajectory planning and execution across the spectrum of time horizons, from
1417 strategic planning to tactical decision making, is one of the key concepts associated with TBO.
1418 Strategic aspects of TBO include the planning and scheduling of flight operations and the
1419 corresponding planning and allocation of resources to meet demand. Tactical components of
1420 TBO include the evaluation and adjustment of individual trajectories to synchronize access to
1421 airspace system assets (or to restrict access, as required) and ensure separation.

1422 New ANSP personnel roles and supporting operations build on the use of TBO to provide ATM
1423 services. Air traffic services are provided through the generation, negotiation, communication,
1424 and management of both individual 4DTs and aggregate flows representing the trajectories of
1425 many aircraft. Flexible route definitions allow traffic flows to be shifted, as necessary, to enable
1426 more effective weather avoidance; meet environmental, defense, and security requirements; and
1427 manage demand into and out of the arrival/departure environment.

1428 Capabilities for managing airspace structure include a common mechanism for implementing
1429 and disseminating information on the current airspace configuration to ensure that all aircraft
1430 meet the performance requirements for any airspace they enter. Distributing information on the
1431 status of SAA will maximize airspace access and minimize disruptions to commerce. Using
1432 automation to manage uncertainties associated with weather better minimizes airspace capacity
1433 limitations and reduces the likelihood of overly conservative actions. Different aircraft and flight
1434 crews also have varying levels of ability and preferences to operate in specific weather

1435 conditions. Individual flight limitations and preferences are key inputs to flight planning and
1436 execution, and flight operators may dynamically update these features. With this knowledge, the
1437 ANSP can support 4DTs tailored to individual flight preferences.

1438 Within TBOs, some aircraft support additional operations via onboard capabilities and associated
1439 crew training, including the ability to perform delegated separation, airborne self-separation, and
1440 low-visibility approach procedures. Overall, these new kinds of flight operations dramatically
1441 improve en route productivity and capacity and are essential to achieving NextGen. Delegation
1442 of ATM functions to capable aircraft means these services are provided only when and where the
1443 aircraft need them, promoting scalability of the overall ATM system.

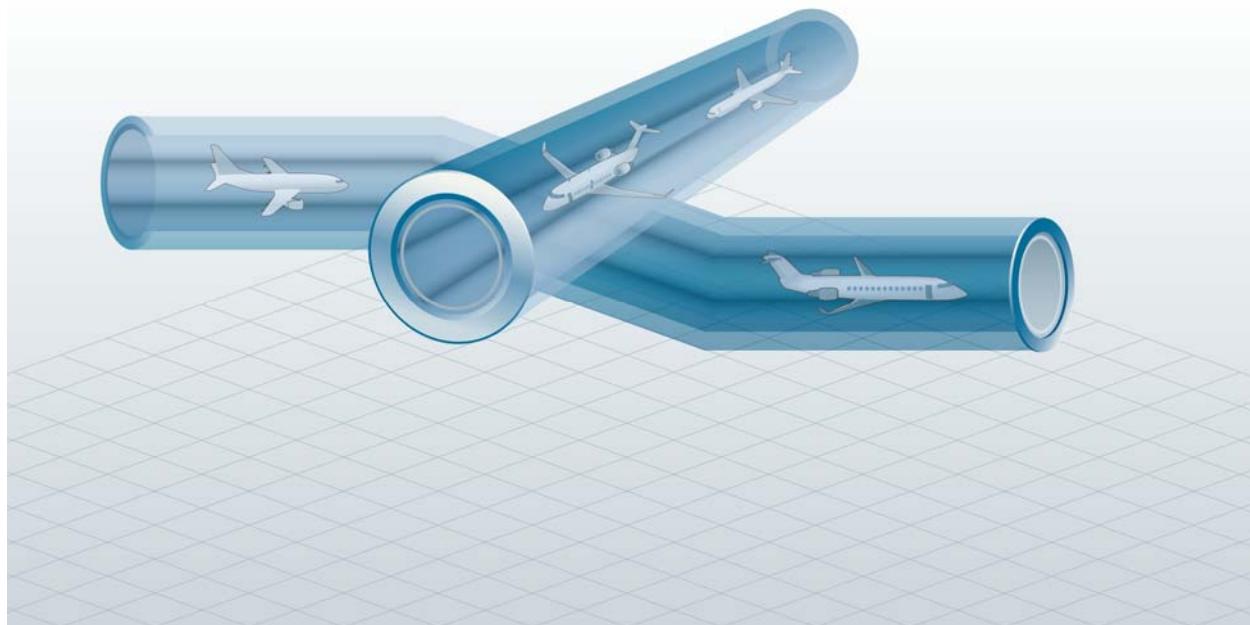
1444 In the highest density arrival/departure areas, high-density arrival/departure operations are
1445 implemented to maximize airport throughput at times of peak demand while facilitating efficient
1446 arrival/departure profiles for equipped aircraft. High-density arrival procedures usually require
1447 airborne separation ability, and may be continued on the airport surface where required for
1448 throughput. Other arrival/departure areas with less demand, as well as high demand
1449 arrival/departure areas during off-peak hours, provide access to a wider range of aircraft. Aircraft
1450 routinely conduct low-noise approaches, mitigating noise impacts.

1451 **2.3.3.2 *En Route and Cruise TBO***

1452 Operational distinctions between oceanic and en route airspace fade as performance-based
1453 operations and advanced CNS technologies become the norm. Some operational considerations
1454 remain for oceanic and remote airspace (e.g., when there are long distances between suitable
1455 landing locations). These operations accommodate aircraft equipped only for basic 4DT
1456 procedures, possibly along structured routes, when aircraft that are more capable are occupying
1457 the efficient routes and altitudes.

1458 4DT procedures allow the ANSP to precisely schedule traffic through congested airspace,
1459 especially as aircraft start to converge approaching a major airport. When demand is very high,
1460 the ANSP may implement “flow corridors” for large numbers of separation-capable aircraft
1461 traveling in the same direction on very similar routes. (See Figure 2-5) Flow corridors consist of
1462 long tubes or “bundles” of near-parallel 4DT assignments, which consequently achieve a very
1463 high traffic throughput, while allowing traffic to shift as necessary to enable more effective
1464 weather avoidance, reduce congestion, and meet defense and security requirements. Flow
1465 corridors are designated for participating aircraft only.

1466

Figure 2-5 Flow Corridors

1467

1468 The 4DT assignments in a flow corridor do not ensure that conflicts never occur, but do ensure
1469 that any conflicts are easily resolved with small speed or trajectory adjustments even with the
1470 high traffic density. The corridor is large enough for aircraft to use their separation capabilities
1471 for entering and leaving the corridors, as well as for overtaking, all of which are accomplished
1472 with well-defined procedures to ensure safety. Flow corridors are procedurally separated from
1473 other traffic not in the corridor. The high traffic density achieved increases the airspace available
1474 to other traffic and often eliminates the need for a TMI; thus, the flow corridor is implemented
1475 along the optimum routes and altitudes. The corridor may be dynamically shifted to avoid severe
1476 weather or take advantage of favorable winds. Procedures exist to allow aircraft to exit the
1477 corridor safely in the event of a declared emergency.

1478 For scalability and affordability, the ANSP delegates separation tasks to capable aircraft
1479 whenever this benefits the aircraft involved, overall operations, or ANSP productivity. Some
1480 airspace is designated as self-separation airspace where self-separation operations are required.
1481 En route trajectory-based procedures are summarized in Table 2-1.

Table 2-1 Summary of En Route and Oceanic Trajectory-Based Operations (TBO)

Operation	Benefit	ANSP Ability	Aircraft Ability	Provision of Separation
ANSP-Managed Operations	High traffic density; accommodate wide range of aircraft capabilities	4DT exchange, including updates for SM, TM	Exchange and execute 4DT, CTA, RNP; some aircraft have delegated separation ability	ANSP via automation; or ANSP delegates to aircraft

Operation	Benefit	ANSP Ability	Aircraft Ability	Provision of Separation
Flow Corridors	Very high traffic density; preferred routing; ANSP productivity	4DT exchange with reduced requirement for updates, TM	Exchange and execute 4DT, CTA, RNP; delegated separation ability	Procedural separation of corridor from other airspace; aircraft within corridor separate themselves
Self-Separation Operations	Preferred routing; ANSP productivity	FCM, manage entry to/exit from self-separation airspace	Exchange and execute 4DT, CTA, RNP; full self-separation	Aircraft

1483 **2.3.3.3 Arrival/Departure TBO**

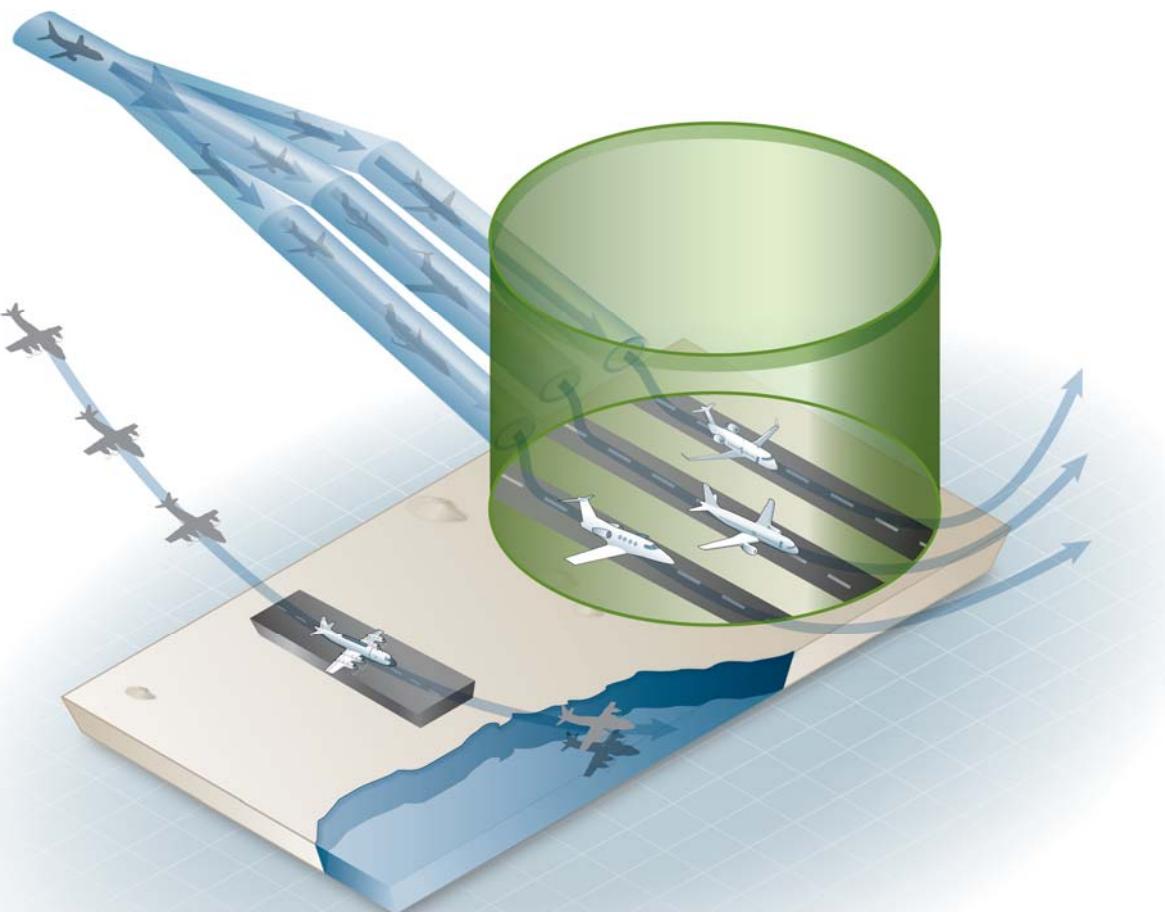
1484 The ANSP manages airspace where there is high-density traffic, including aircraft arrivals and
 1485 departures from complex and dense en route airspace, with the TM and SM functions supported
 1486 by advanced automation. Integrated arrival/departure area and airport surface management
 1487 ensures that arrival flows match projected airport capacity for improved overall throughput and
 1488 efficient flight trajectories that eliminate today's low-altitude path stretching and holding.
 1489 Aircraft are typically assigned final 4DT arrival profiles at the top of descent. The development
 1490 of quieter aircraft, coupled with widespread implementation of low-noise approaches, eases
 1491 restrictions currently imposed for noise abatement at many airports. Rotorcraft and other
 1492 "runway-independent" aircraft needing access to trajectory-based arrival/departure areas are
 1493 coordinated with the major fixed-wing flows to avoid congestion and improve the overall flow of
 1494 both types of aircraft. Table 2-2 presents arrival and departure procedures.

1495 **Table 2-2 Arrival and Departure Procedures**

Operation	Benefit	ANSP Ability	Aircraft Ability	Provision of Separation
Optimized Profile Descent (OPD), other RNP trajectories	Reduced environmental effects; high throughput	4DT exchange, TM, SM	Exchange and execute 4DT, CTA, RNP, OPD; airborne spacing	ANSP automation
Merging and spacing	Arrivals matched to runway capacity, ANSP productivity	TM, 4DT exchange, SM	Exchange and execute 4DT, RNP; airborne spacing	ANSP automation
CSPA, paired approaches	Closely spaced runways maintain Visual Meteorological Conditions (VMC) capacity in all visibility conditions	TM, 4DT exchange to establish aircraft on approach; SM wake vortex monitoring and automation	Exchange and execute 4DT, RNP; delegated separation	ANSP automation, except between aircraft conducting approach

- 1496 At times of peak demand, major airports conduct high-density arrival/departure operations,
1497 implementing capacity-enhancing arrival and surface procedures to maximize runway
1498 throughput. Other airports with lower demand have fewer restrictive aircraft capability
1499 requirements, while some airports may serve aircraft of mixed equipage and capabilities
1500 depending on the airport configuration and level of demand.
- 1501 High-density operations may be required at more airports than today's Class B (39 busiest US
1502 airports) airports to handle the projected traffic increase. At times, high-density operations may
1503 restrict access to high-capability aircraft; however, airports only designate high-density
1504 operations when warranted by demand, and revert to accepting all trajectory-based traffic at
1505 other times of the day. As illustrated in Figure 2-6, high-density arrival/departure corridors
1506 handle arriving and departing traffic, while much of nearby airspace remains available to other
1507 traffic.

1508 **Figure 2-6 High-Density Operations**



1509

- 1510 Abilities used to achieve high-density arrival/departure operations are likely to include the
1511 procedures listed in Table 2-2 above and the following:
- 1512 • Use of RNP operations.
- 1513 • Use of procedures that eliminate requirements for visual operations.
- 1514 • Mitigation of wake vortex constraints through detection and real-time adaptation of applied
1515 separations.
- 1516 • Improved runway incursion prevention procedures and technologies.
- 1517 • Automatic distribution of runway braking action reports.
- 1518 • Distribution of taxi instructions before landing that can be automatically executed without
1519 waiting for a separate clearance.

1520 **2.3.3.4 Surface and Tower Operations**

1521 Surface operations at high-demand airports are integrated with other ATM functions, including
1522 departures, arrivals, and collaborative traffic management. Improved surveillance, automation,
1523 and information sharing enhance surface and tower operations for all traffic. The busiest airports
1524 at peak times (most likely those implementing high-density arrival/departure operations),
1525 conduct high-density surface operations for adequately equipped traffic to maximize runway
1526 throughput and minimize taxi times while moving aircraft safely and with robust runway
1527 incursion prevention. ATC towers provide enhanced services compared to those available today.
1528 Particularly in low-visibility conditions, the ANSP can safely make more efficient use of
1529 runways through real-time depiction in the tower of the location and intent of arriving and
1530 departing aircraft, as well as any aircraft intending to cross an active runway. Lower-demand
1531 airports may implement staffed or automated NextGen towers to provide tower services
1532 equivalent to those of traditional towers. This allows tower services to be provided at more
1533 airports than is affordable today and/or for extended hours of service. Table 2-3 provides a
1534 summary of surface transformations.

1535 **Table 2-3 NextGen Surface Operation Transformations**

Current Roles	Corresponding NextGen Roles
Ground surveillance available to ANSP limited. Primary and some secondary surveillance abilities are installed, providing conflict resolution and information, but limited to Operational Evolution Partnership airports. Runway incursion prevention automation is also limited	Cooperative ground surveillance at most airports, including state vector information (e.g., aircraft speed/direction), with more effective runway incursion prevention automation
Essentially no cockpit surveillance of other ground traffic/vehicles, other than visual (out the window)	Integrated surveillance of ground traffic, along with airport layout and taxi routes, with cockpit warning of runway incursions

Current Roles	Corresponding NextGen Roles
Surface movement information (e.g., pushback, departures, and taxi delays) mostly not integrated with Traffic Flow Management (TFM). Difficult to implement flight-specific TMIs	Updated pushback information provides improved surface and departure management. Surveillance of surface movement provides basis for more accurate departure time and taxi delay estimates. Availability of improved departure time estimates significantly improves ability of FCM and TM. Flight-specific TMIs are handled via automation and data communications.
Many non-towered airports	Automated NextGen Towers (ANT) or better where economically feasible
Inefficient one-in-one-out operations at smaller airports without approach controls or towers	Elimination of one-in-one-out restrictions at most airports for equipped aircraft

1536

1537 2.4 TRANSFORMED ROLES AND RESPONSIBILITIES

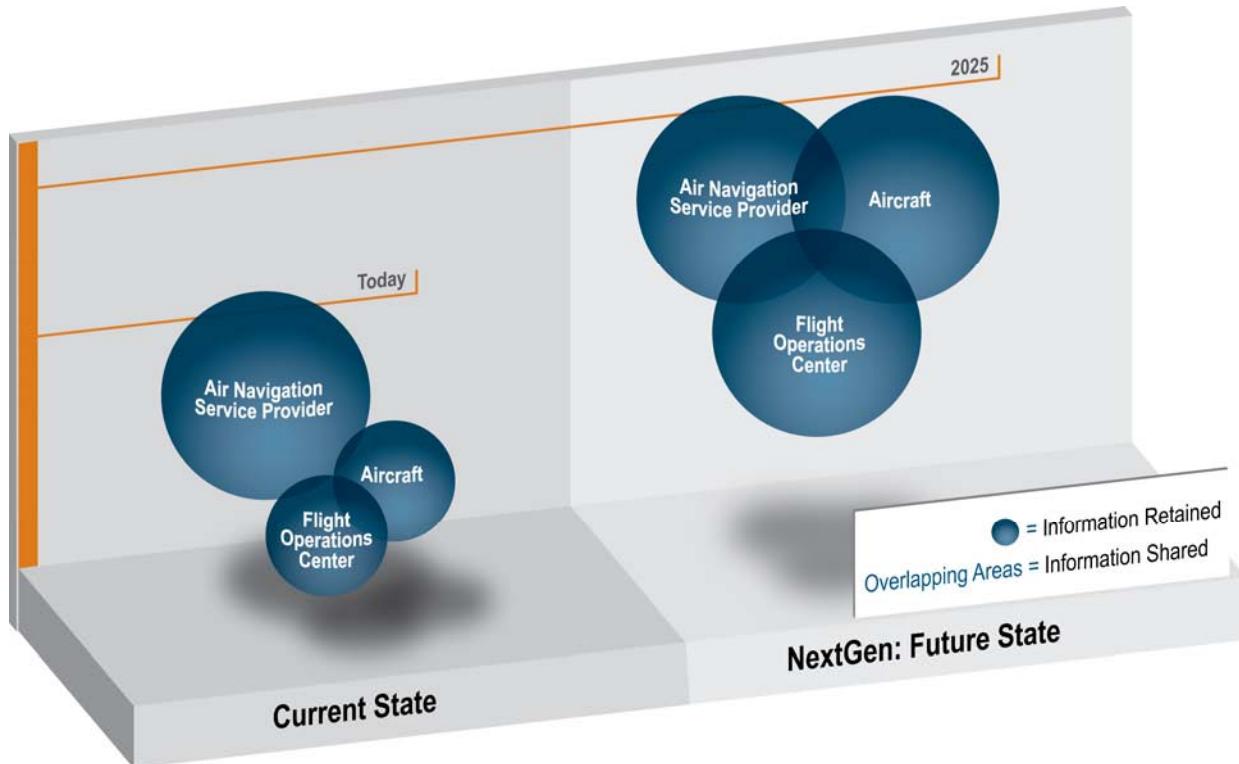
1538 With increased demand anticipated in the next 10 to 15 years and the subsequent increase in
1539 complexity of operations, the NextGen environment requires changes in roles for ANSP
1540 personnel and flight operators. Automation performs new tasks, supporting the decision making
1541 process, and shifting the focus from tactical separation between individual aircraft to the strategic
1542 management of traffic flows in high-density airspace. Flight operator roles change accordingly.
1543 As illustrated in Figure 2-7, ANSP personnel, flight crews, and flight planners have more
1544 distributed decision making, with a significant increase of information exchange. Flight planners
1545 have an increased role in collaborating with the ANSP on capacity and flow management
1546 strategies, and the flight crew has a greater role in many of the tactical flight management tasks.
1547 For some aircraft, the flight crew also begins to take on a more strategic flight management role,
1548 building on aircraft automation.

1549 Today's NAS, in which controllers provide safe aircraft separation by issuing tactical clearances
1550 for individual aircraft, is reaching its capacity as splitting sectors further produces diminishing
1551 benefits. A new paradigm is required to manage human workload better, increase productivity,
1552 and leverage advanced automation capabilities. This, in turn, requires transformation to achieve
1553 scalability and affordability goals, including the following:

- 1554 • Restructuring the roles of humans and automation and how they perform their respective
1555 functions to synergize human and automation performance.
- 1556 • Better distribution of tasks and decision making between service providers, flight crews,
1557 and flight planners to achieve operational efficiencies and scalability.
- 1558 • Broadening the resource pool of service providers by eliminating the "hard-wired"
1559 connection between service providers and geographic regions (Chapter 4).

1560 The following subsections discuss these transformations in further detail.

1561

Figure 2-7 Relative Influence of the ANSP and Aircraft/Pilot in ATM Decisions

1562

2.4.1 Functional Task Allocation

1564 The ATM system capitalizes on human and automation capabilities. It employs complementary
1565 air and ground technologies in a distributed manner. Both humans and automation play important
1566 and well-defined roles, which take advantage of the types of functions each can best perform.
1567 Service providers and flight operators are given appropriate roles.

1568 Automation supports the migration from tactical to strategic decision making by assimilating
1569 data and supplying information as well as by performing many routine tasks. Ultimately, the
1570 determination of when to fully automate and when to provide decision support is made to
1571 optimize overall system performance and ensure that service providers and flight operators
1572 perform well and can respond to off-nominal and emergency events when required.

1573 Increased reliance on automation is coupled with “fail-safe” modes that do not require full
1574 reliance on humans as a backup for automation failures. In addition, the system distributes
1575 backup functions throughout, and there are layers of protection to allow for graceful degradation
1576 of services in the event of automation failures.

2.4.2 Human-to-System Interactions

1578 Human-to-system interactions are designed to gain safety, productivity, efficiency, and
1579 scalability benefits. Human factors considerations are paramount to maximizing ANSP

productivity and performance and are integrated into system acquisition management and planning. Human factors considerations that drive human-to-system design and impact human-to-system performance include human cognitive capabilities and limitations, human error, situational awareness, workload, function allocation, hardware and software design, procedural design, decision aids, visual aids, training, user manuals, warnings and alarms, environmental constraints, workspace design, and team versus individual performance.

Human interactions with automation are more intuitive and user-friendly, allowing increased utility of tools while mitigating human error. New tools, measures, and mechanisms are in place to preclude and mitigate the effects of human error, with error tolerance and error resistance achieved through human-centered design processes. Service providers and flight operators are presented with well-integrated user interfaces. Flight deck systems are easier to use and better integrate information for situational awareness and decision making. Likewise, ground automation systems seamlessly integrate decision aides such as automated conflict detection and resolution.

2.4.3 Flight Operator Roles and Vehicle Types

NextGen includes a wide diversity of flight operators and flight operations. Flight operators, the primary users of ATM services, have a range of objectives for operating flights, depending on their business models. Examples of flight operators and their objectives include the following:

- **Scheduled Operators** - primary objective to maintain schedule integrity and operating efficiency. For many operators, the ability to accommodate growth in schedules is also important.
- **On-Demand Operators** - objectives include continual and equitable access to resources and operating efficiency.
- **Corporate Operators** – objective to maintain access to support business needs (not necessarily aviation) for the conduct of commerce.
- **State and Military Operators** - require access to all areas and may, at certain times, require special accommodation for aircraft that do not meet all expected capability and performance requirements. These operators may also require priority access to complete a specific mission or objective. Military operators require the ability to operate in areas designated for their special use to conduct training and proficiency operations.
- **Space Vehicle Operators** - require routine access to operate on the way to and from space, according to schedules that are known well in advance.

This ConOps uses the term “flight operator” to encompass all people or organizations that operate aircraft, including scheduled, on-demand, personal aircraft, and state and military aircraft operators, and emerging flight operations such as unmanned aircraft and space vehicles. The common theme for this diversity of ATM customers is their transformed ability to achieve their business and operational objectives through access to reliable real-time information relevant to their proposed operation, to understand the impact of their decisions related to their operations, and to negotiate with the ANSP to achieve their objectives. Many operators have advanced

capabilities that are complementary to the ANSP and can take advantage of the significant opportunities for access, efficiency, and predictability. These transformed operations provide benefits for any operator that invests in the needed ability, whether GA, commercial, civil, or military. The adoption of performance standards rather than equipment standards encourages innovation by avionics suppliers to produce affordable capabilities supporting trajectory-based procedures and real-time flight information (e.g., weather, airspace configuration, and traffic) in the cockpit.

Benefits desired by flight operators include maintaining schedule integrity, operating efficiently, having access to airspace and airports in the presence of congestion, operating with minimal disruption from weather or visibility, having increased safety and utility, suffering minimal disruptions from security and defense operations, and having reduced operating costs. State and defense providers also have unique needs for access to airspace, including transiting through airspace to complete missions or for training. In addition, a broad community of operators, who fly under VFR, continues to want access to airspace.

Flight operators have a wide range of capabilities and options to meet their mission needs. The minimum ability for operating in any managed airspace is cooperative surveillance, the ability to perform RNAV operations (if operating under IFR), and communication with the ANSP via voice radio. In airspace where TBO is used (Section 2.3), the minimum ability includes the ability to conduct RNP operations combined with the exchange (via a digital data link) and execution of precision 4DTs. Digital data communications between flight operators and the ANSP are the norm performed in TBO airspace; voice is used as a backup and on exception. Some airspace requires the ability to perform delegated or self-separation operations in addition to the above. Many aircraft are capable of digital data communications to communicate with the ANSP (for clearances, requests, and aeronautical information) to send and receive weather information and to receive surface movement instructions. Many operators also are able to communicate between aircraft and their FOC for exchanging flight planning and trajectory information, aircraft performance and maintenance data, flight following information, and passenger-related information. Flight planning systems also have a range of capabilities, including the ability to exchange and negotiate information supporting the C-ATM process.

Each operator makes choices, based on their own business model, about the desired operations and the tradeoffs between increased levels of service from the ANSP versus the needed investment in flight planning and aircraft capabilities and performance. As operations grow in level and complexity, operators continue to make choices on whether to invest in needed capabilities and training, if additional procedures are required to operate.

2.4.3.1 *Flight Operator Roles*

Flight operator roles during flight planning and flight execution vary based on flight operator capabilities. Table 2-4 highlights projected changes in flight operator roles. Other flight operator roles such as marketing and strategy development are outside the scope of this document.

1657

Table 2-4 Flight Operator Roles

Current Roles	Corresponding NextGen Roles
<p>Dispatcher/FOC Personnel</p> <p>Responsible for originating and disseminating flight information, including flight plans.</p> <p>Responsible for operational control of day-to-day flight operations. Also responsible for understanding weather and other constraints, incorporating these into flight plans, and in some organizations, coordinating with ANSP personnel regarding overall flow issues.</p> <p>GA operators also may interact with third-party (fee-for-service) vendors who provide weather and other services (e.g., flight planning) through dedicated computer terminals, direct phone contact, or the Web.</p>	<p>Flight Planner</p> <p>Responsible for making tactical decisions about what flights to operate and when and where they operate. May be the same as flight crew. Is the interface with the ANSP C-ATM function to develop collaborative capacity and TFM decisions and in trajectory negotiation.</p> <p>Operators with multiple aircraft involved in the initiative have the flexibility to adjust individual aircraft schedules and trajectories within those allocations to accommodate their own internal business concerns, both preflight and in flight.</p> <p>Dispatcher/FOC</p> <p>Responsible for insuring that all legal requirements for the flight will be met. Also responsible for coordinating with the flight planner, ANSP and flight crew with regard to tactical decisions prior to and during the execution of a flight to maintain an optimum flight trajectory. Provide data for departure delays (mechanical, passenger, icing, etc.), en route modifications, "own flights" sequencing and destination diversions.</p>
<p>Flight Crew</p> <p>Responsible for the control of an individual aircraft while it is moving on the surface or airborne.</p>	<p>Flight Crew</p> <p>Responsible for the control of an individual aircraft while it is moving on the surface or airborne. Under delegated operations, responsible for separation. May comprise a single pilot or multiple individuals (e.g., two pilots). UAS / RPA may be pilot controlled from a ground control station or automata controlled for autonomous operations using pre-programmed mission information, and aircraft status monitored by the pilot.</p>

1658

1659 The roles of the flight crew for advanced aircraft include managing aircraft systems to include
 1660 supervisory override, and participating in the C-ATM function. When separation is delegated,
 1661 the flight crew assumes the role of separation manager as well. For aircraft not equipped with
 1662 TBO-enabling technology, the flight crew operates much as today, including those operating
 1663 under VFR. In the supervisory override role, the flight crew is responsible for operating the
 1664 aircraft and taking any actions deemed necessary to correct system malfunctions that occur
 1665 during flight. During surface operations, the flight crew has full control of the aircraft and is
 1666 responsible for maneuvering it and determining if it is fully functional before takeoff. For some
 1667 aircraft, flight management automation may be used for surface operations as well.

1668 Pilot-in-Command (PIC) authority is always present, and has the prerogative to take any action
1669 necessary to ensure the safe operation of the aircraft. When exercising their authority, the PIC is
1670 directly responsible for taking actions necessary to correct system malfunctions or safety of
1671 flight issues that occur during flight operations.

1672 ***2.4.3.2 State and Military Operations***

1673 Many state aircraft—primarily those operated by the military—require transition between
1674 seamless operations among civil aircraft and exceptional flight requirements (e.g., needing
1675 special services from the ANSP or departing airspace managed by the ANSP) during a single
1676 flight. The initial phases of the mission operate in similar fashion to those of civil users until the
1677 unique operation is conducted (i.e. aerial refueling). At that point, the operation becomes unique
1678 and remains so until the special operation is completed. Once complete, the ANSP re-integrates
1679 the aircraft into normal NAS operations.

1680 ***2.4.3.3 Unmanned Aircraft Systems (UAS)***

1681 UAS operations have the potential to be some of the most demanding. They include scheduled
1682 and on-demand flights for a variety of civil, military, and state missions. There has been a
1683 significant increase in demand for UAS operations particularly by military and public agencies in
1684 order to provide an expansion of current manned aircraft capabilities. In many cases unmanned
1685 aircraft have assumed missions traditionally flown by manned aircraft due to their unique
1686 capabilities, greater mission effectiveness, reduced risk, lower operating costs, and increased on
1687 station times.

1688 Non-Military Public Agency UAS operations include atmospheric research, border and maritime
1689 security operations, weather measurement and tracking, natural disaster and humanitarian
1690 response, search and rescue, law enforcement, drug surveillance and interdiction,
1691 communications relay and more.

1692 Additionally, the growth opportunities for civil UAS applications are exponential and may
1693 include news media support, communications relay, agricultural applications, aerial photography
1694 and video, remote imagery and mapping, mining exploration, site security and surveillance,
1695 natural disaster assessment and monitoring, and cargo operations. UAS capabilities vary widely
1696 depending on size, performance, and function. The individual groups of UAS are categorized by
1697 attributes of airspeed, weight, and operating altitude.

1698 UAS operators are expected to fly 4DT procedures; however, because of the broad range of
1699 operational uses, UAS operators may require access to all airspace. The UAS operators are
1700 capable of conducting the procedures required for the airspace and must achieve the same target
1701 level of safety as manned aircraft in preventing collisions. The method(s) for ensuring sense and
1702 avoid is dependent on the designator of airspace in which the UAS is operating.

1703 ***2.4.3.4 Vertical Flight***

1704 Rotorcraft, tiltrotor, Vertical/Short Takeoff and Landing (V/STOL), and similar aircraft have
1705 multi-axis and dynamic flight capabilities that differ from fixed-wing aircraft, which allow them
1706 added flexibility for use in unique and demanding missions.

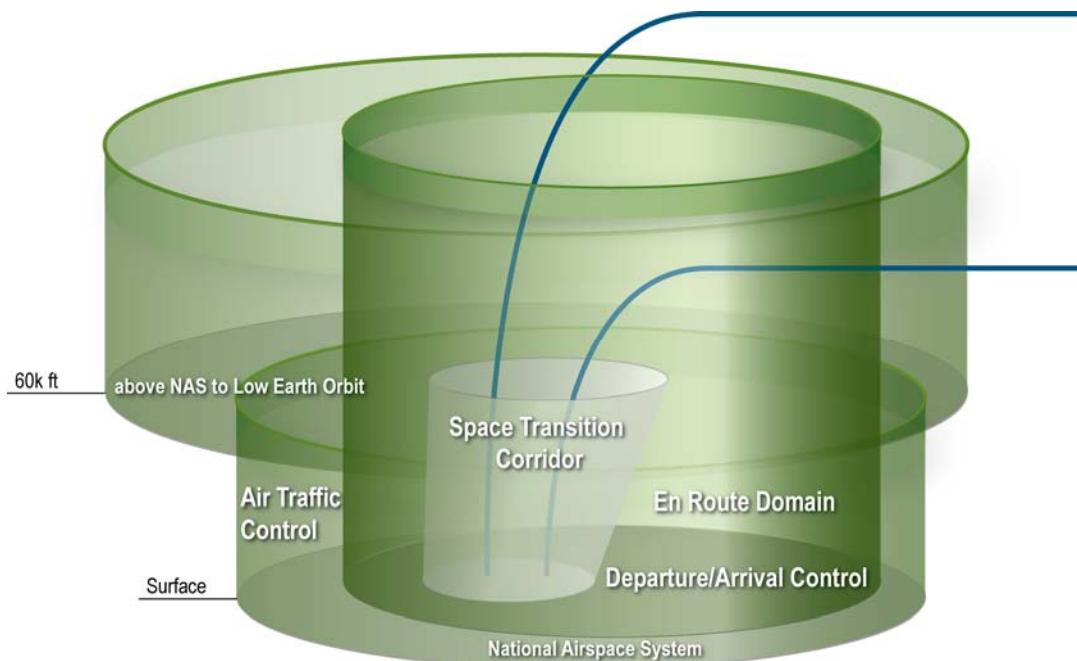
1707 Users are acquiring transport category IFR-capable rotorcraft in larger numbers. With growing
1708 ground congestion, these aircraft have increased utilization. In addition to civil uses, rotorcraft
1709 continue to have an increasing role in homeland security and other missions. They provide
1710 public safety, disaster response, search and rescue, and emergency medical services in all areas
1711 of the United States and increasingly perform Instrument Meteorological Conditions (IMC)
1712 operations. These operations add to the density and complexity of operations, particularly in and
1713 around urban areas.

1714 **2.4.3.5 Trans-Atmospheric and Space Operations**

1715 Some aircraft are destined for specific mission operations at Flight Level (FL) 600 and above.
1716 These “near-space” and space operations continue and expand in diversity. Near-space and space
1717 aircraft exhibit a wide variance in capability and vehicle performance (e.g., aerostats, medium-
1718 and high-speed research/reconnaissance aircraft, suborbital spacecraft, launching and reentering
1719 orbital spacecraft). Some users of this airspace are expected to have unique needs that can be
1720 accommodated only with security-restricted airspace-equivalent to today’s Temporary Flight
1721 Restrictions (TFR).

1722 In the future operational environment, ANSP facilities will be responsible for maintaining the
1723 safe and efficient flow of both air traffic and space traffic within the NAS. ANSP facilities work
1724 with spaceports and space traffic management, as illustrated in Figure 2-8, to ensure safe and
1725 efficient operations within the NAS, as spaceflight vehicles depart and return on their way to or
1726 from space. ANSP facilities have the authority to impose airspace restrictions, reroute air traffic,
1727 instruct spaceports to hold spaceflight vehicles on the ground, or (in emergency situations) divert
1728 flight vehicles to alternate destinations, as means of accommodating spaceflight vehicle
1729 departure and return operations through the NAS.

1730 **Figure 2-8 Space Operations in the NextGen NAS⁵**



1731

⁵ FAA, Space Vehicles Operators Concept of Operations, 2008.

1732 2.4.4 Transformations in ANSP Processes

1733 ANSP service delivery mechanisms are transformed to provide ATM services in a safer, more
1734 secure, scalable, and affordable manner. Processes are revolutionized, from the way ANSP
1735 personnel are trained and allocated to airspace to the way long-term capacity changes are
1736 managed. The changes in ANSP processes and personnel management are geared toward the
1737 following goals:

- 1738 • Managing resources dynamically to enable the ATM system to apply people where their
1739 services are most needed.
- 1740 • Managing and configuring facilities (including airports) appropriately.
- 1741 • Designing airspace and designating its use to complement operations.
- 1742 • Ensuring that the ATM system is globally harmonized through collaborative development
1743 and implementation of identified best practices in both standards and procedures.
- 1744 • Ensuring that safety, security, and environmental considerations are fully integrated into
1745 ATM.

1746 Within the ANSP workforce, the emphasis is on strategic flow management and collaboration
1747 with airspace users. Flow contingency managers monitor and assess capacity requirements for
1748 traffic flows. With DSTs, they determine optimum flow and airspace configurations in
1749 collaboration with capacity managers and through collaboration with flight operators and other
1750 stakeholders. Separation managers and trajectory managers interact to determine optimum
1751 system solutions and implement decisions strategically. A broad set of strategic ANSP functions
1752 include the following:

- 1753 • Forecasting demand to support effective and timely capacity planning.
- 1754 • Managing capacity, including dynamic management of NAS resources.
- 1755 • Collaborating with airspace users on flow management strategies.
- 1756 • Managing trajectory and negotiating with flight operators, if needed.
- 1757 • Maintaining the flight object and providing flight planning support.
- 1758 • Providing flow strategy and trajectory impact analysis services.
- 1759 • Maintaining the net-centric infrastructure and providing other NAS infrastructure services
1760 (e.g., navigation and surveillance).
- 1761 • Coordinating changes to U.S. and international procedures.

1762 Some of these functions are new; many are enhanced. Existing functions (e.g., forecasting
1763 demand, providing navigation and surveillance services) are also transformed. The
1764 transformations are discussed in subsequent chapters. In addition, although flight planning and
1765 weather services are automatically disseminated or provided by third-party service providers,
1766 ANSP personnel still provide safety-critical, in-flight services.

1767

Table 2-5 Air Navigation Service Provider Personnel Roles

Current Roles	Corresponding NextGen Roles
Area Supervisors, Airspace Designers Design and strategically allocate airspace. Adjust the assignment of airspace to tactical separation providers (primarily by combining and de-combining sectors). Structure routings (air and ground) where required.	Capacity Managers in Collaboration with Airspace Users and Flight Operators Design and strategically allocate airspace. Dynamically adjust the assignment of airspace to tactical separation providers. Structure routings (air and ground) where required, and flexibly allocate airspace for other purposes, including the operation of state (government) aircraft.
Traffic Management Specialists/Coordinators Identify potential flow problems, such as large-demand capacity imbalances, congestion, high degrees of complexity, and blocked or constrained airspace (e.g., for special use, weather), and collaborate on TMIs.	Flow Contingency Providers in Collaboration with Flight Operators Identify potential flow problems, such as large-demand capacity imbalances, congestion, high degrees of complexity, and blocked or constrained airspace (e.g., for special use, weather), and collaborate to develop flow strategies (i.e., aggregate trajectory solutions).
Traffic Management Specialists/Coordinators, Air Traffic Controllers Ensure that TMIs are carried out. Perform planning for flights entering sector, identify future conflicts (i.e., strategic SM), and coordinate resolutions with adjacent sectors.	Trajectory Managers in Collaboration with Flight Operators Predict individual flight contention within a flow for resources, identify complex future conflicts (i.e., strategic SM), and coordinate individual trajectory resolutions. This is focused on near-tactical management of individual trajectories within a flow.
Air Traffic Controllers Provide tactical separation to separate aircraft from other aircraft and SAA, and organize and expedite the flow of traffic.	Separation Managers (May Be Flight Crew Depending on the Airspace and the Operation) Eliminate residual conflicts left by the three strategic functions of TBO. Automation detects the conflicts and provides the resolution.
Flight Service, Third-Party Service Providers Provide flight planning and weather services (e.g., Direct User Access Terminal [DUAT]).	Automated Dissemination to Operators and Flight Crews, FOCs, Third-Party Service Providers Provide flight planning support and weather services. ANSP role is limited to safety-critical in-flight assistance. Operators may also interact with third-party weather providers or their own FOC.

1768

Because NextGen transformations significantly change the roles and responsibilities of ANSP personnel, substantive and organic changes in ANSP personnel management are necessary. Transformations with the largest impact include:

1772

- TBO and airspace.
- Performance-based separation standards.

1773

- 1774 • Greater levels of coordination between aircraft and flight crew in operations.
- 1775 • Reliance on intelligent automation, including for tactical SM.
- 1776 • Emphasis on strategic flow management to minimize the need for tactical separation maneuvers.
- 1777 • Dynamic assignment of airspace boundaries and associated operations.
- 1779 These operational transformations require corresponding transformations in ANSP personnel selection, staffing, training policies, and practices to meet performance objectives (Table 2-6). Considerations include:
- 1780 • Personnel selection (e.g., minimum skill levels, special skills, experience levels, cultural issues).
- 1781 • Staffing (e.g., staffing levels, team composition, job design, team communication, organizational structure).
- 1782 • Training (e.g., training regimen, training effectiveness, skill retention and decay, retraining, emergency operations training, training devices and facilities, embedded training).

1783 **Table 2-6 Personnel Management Transformations**

Significant Transformation	2006 Current	2025 NextGen
Personnel Skills and Selection	Tactical (sector) controllers dominate ATC workforce. Controllers must learn local characteristics of airspace. Skill sets are matched to traffic characteristics within airspace (e.g., high-altitude cruise, transition, terminal).	Separation managers are assigned only to aircraft not equipped to a sufficient level of TBO-enabling technology for a given operation. Common airspace/flow configurations, DSSs, and a net-centric information management system minimize the need for local airspace knowledge. Skill sets are matched to traffic characteristics in airspace.
Flexible Staffing	Controllers are assigned to one area of specialty within a facility. Sectors are combined/de-combined to manage workload. Constant adjustments are made to facility staffing levels to match traffic levels; facility grade is assigned by traffic levels.	ANSP personnel are assigned in and across facility boundaries to match staffing to traffic demand. Airspace assignments change dynamically. Different operational grade levels exist within a general service delivery point to support career progression.

Significant Transformation	2006 Current	2025 NextGen
Training	Facility training is the longest part of training to learn local characteristics of airspace. Training emphasizes tactical separation in a variety of conditions and traffic loads.	Commonly configured airspace reduces facility training time from months to weeks or days. Training emphasizes management of off-nominal operations.

1790

1791 New procedures, technologies, and infrastructure combine to perform ANSP service delivery, significantly increasing safety, security, and capacity of air traffic operations in the NAS. The 1792 ANSP will require different automation, procedures, and skill sets than those utilized in today's 1793 ATC environment. NextGen minimizes the requirement for the service provider to retain local 1794 knowledge of the airspace (e.g., frequencies, airspace fixes, and handoff procedures); therefore, 1795 the airspace can be treated like commonly-configured airspace. This is particularly true at high 1796 altitudes. Commonly-configured airspace affords great flexibility in the airspace and 1797 corresponding traffic to which ANSP personnel can be assigned and in the frequency with which 1798 the assignments can dynamically change. It also enables the reclassification of ANSP personnel 1799 commensurate with the new types of operations. Direct-addressable communication reduces the 1800 requirement for frequency management and knowledge. Currently, ANSP personnel provide 1801 tactical separation and must accommodate multiple aircraft capabilities. The skill set of the 1802 ANSP personnel is similar to that of a radar controller.

1803

1804 New approaches to staff air traffic facilities take advantage of available resources and provide 1805 additional opportunities for career growth. Automated staffing tools help facility managers match 1806 staffing to traffic demand, so that management of NAS resources is dynamic and flexible enough 1807 to adjust to changes in the market as well as changes to daily and seasonal traffic flow. New 1808 communication, data, and surveillance capabilities help manage ebbs and flows in traffic levels 1809 efficiently, unconstrained by facility boundaries. By decoupling geographic airspace and 1810 infrastructure constraints from aircraft operations, capacity managers have the flexibility to 1811 leverage resources across facilities to match staffing to traffic demand.

1812 Co-locating operational domains (e.g., tower control and terminal airspace, approach control and 1813 en route airspace) of differing complexity levels into general service delivery points allows 1814 service providers to advance to higher grade levels without having to relocate. This has the dual 1815 benefit of providing employees better opportunities for career progression while dramatically 1816 decreasing operating, maintenance, infrastructure, and permanent-change-of-station costs.

1817 All air traffic facilities benefit from scheduling and workforce management improvements. SNTs 1818 allow ANSP personnel to service multiple airfields from a single physical location. The ability 1819 to use SNTs enables airports to receive tower services that they normally do not receive, given 1820 the criteria of today and the costs of building a tower. In addition, ANTs are an innovative, 1821 affordable way to provide new services where service delivery was not practical before. ANTs 1822 are beneficial for smaller, towered airports or SNT airports, as they continue providing existing 1823 services during off-hours at reduced staffing costs. A voice interface ensures that aircraft without 1824 data communication equipage can receive service.

- 1825 Commonly configured airspace significantly reduces the time required to achieve various levels
1826 of ANSP personnel certification from months to weeks or days. The elimination of inter-facility
1827 letters of agreement and the corresponding need to learn all local characteristics of the airspace,
1828 in part, enables reduced training time. This in turn reduces training costs and fosters other
1829 benefits such as increased flexibility in scheduling, more rapid response to staffing needs, and
1830 reduced stress on training resources (e.g., on-the-job training instructors).
- 1831 Various levels of fidelity in training simulators reduce training cost and time. The enhanced
1832 process and inherent simulation capabilities provide for more standardized instruction, unbiased
1833 assessment of performance, mitigation of weaknesses, and useful remedial and proficiency
1834 training. Performance measurement tools evaluate the efficiency and efficacy of training
1835 programs, processes, and paradigms on the development and enhancement of skills performance.
1836 They also measure job performance competencies and related knowledge, skills, and abilities
1837 that determine individual and team safety, efficiency, and effectiveness.
- 1838 Some members of the NextGen workforce are hired into the new roles of ANSP personnel (e.g.,
1839 CM, FCM, TM), while others are retrained from the classic roles of air traffic controller and
1840 traffic flow manager. With a reliance on automation, the ANSP selects and trains personnel to
1841 ensure they can deliver the essential services when off-nominal or emergency conditions exist.
1842 This requires that a significant portion of the training focuses on dealing with emergencies and
1843 exceptional situations in addition to all other necessary skills. This in turn necessitates that
1844 systems not only have a very high level of reliability but also that system failures are controlled
1845 in a gradual degradation, providing ample time to reduce traffic to the reduced capacity levels.
- 1846 Selection criteria tailored to the type of ATM services provided (e.g., tower controller, traffic
1847 flow manager), innovative and flexible staffing techniques, and a revamped training program
1848 ensure that the ANSP workforce is best prepared to meet the demands and challenges.



3 Airport Operations and Infrastructure Services

1849
1850

1851
1852

3.1 INTRODUCTION

1853 Airports are a determining factor in the total capacity of the air transportation system;
1854 accordingly, airports are critical to the overall transformation. Airports serve as the integrative
1855 space between the ground and air. Moreover, they enable aircraft to arrive and depart in a safe,
1856 efficient, and secure manner, while also facilitating the movement of people and cargo, on and
1857 off aircraft.

1858 Achieving the capacity growth needed to meet future demand for aircraft operations and
1859 passenger/cargo movements at airports is a significant challenge. NextGen seeks substantial
1860 improvements in the utilization of existing infrastructure as well as the development of new
1861 infrastructure and technological advancements at both scheduled air transport service and GA
1862 airports to benefit passengers, cargo, and GA aircraft operators that use the NAS.

1863 Unlike other components of the air transportation system that are directly managed by the federal
1864 government, airport decisions are primarily made at the local level. The development or
1865 transformation of an airport hinges on the efforts and decisions of the communities and users it
1866 serves. The factors that drive many airport investment decisions are primarily market- and user-
1867 driven, rather than falling under the jurisdiction of the federal government. Even as airports seek
1868 to be responsive to the needs of the aircraft operators and traveling public, these particular users
1869 are responding to market factors. Factors that are expected to drive airport development and
1870 operations through 2025 and beyond include the following:

- 1871 • Maximizing the use of existing infrastructure, increasing the utilization of GA and
1872 reliever airports, and implementing new ATM procedures that increase airport efficiency
1873 resulting in significant capacity gains. New infrastructure at scheduled air transport
1874 service and GA airports may achieve additional capacity gains.
- 1875 • Some scheduled air transport service hub airports that are approaching capacity today
1876 may not be able to expand reasonably to support unconstrained demand in aircraft
1877 operations or passenger movements. In these cases, the development of existing airports
1878 in the congested area to improve throughput may be necessary to augment regional
1879 capacity.
- 1880 • People and cargo will need to get to and from the airport in a predictable and efficient
1881 manner. Therefore, efficient intermodal transportation networks and information systems
1882 need to link airports with population and business centers.
- 1883 • Collaboration among federal, state, and local agencies will support the effective
1884 governance of airport operations and regional considerations, given the many
1885 stakeholders who have vital interests in a successful airport system.

In recognition of these drivers, the following sections provide available services that airports can adopt, as dictated by their needs and missions. For example, the busiest scheduled air transport service hub airports may need systems to manage ramp operations actively to reduce congestion, while a small hub airport may not warrant this investment. Some scheduled air transport service hub airports that cannot easily expand their terminal buildings may need off-airport passenger processing capabilities, while other airports may need to build expansive, flexible terminals. GA and reliever airports may seek facility improvements and instrument approach access to serve the needs of their operators. Actual implementation of these concepts will be done through traditional local decision making in cooperation with the airport operator, users, and neighboring communities, along with support from local, state, and federal governments.

The “Flexible Airport Facility and Ramp Operations” capability will enable a balance between airside, landside, and terminal airport infrastructure in order to achieve optimal airport capacity. Future growth in aircraft operations cannot be accommodated without application of innovative ATM technologies and procedures, construction of additional infrastructure at major airports, and/or better utilization of existing infrastructure at supporting airports.⁶ NextGen seeks to increase the overall capacity of the existing airport system through the implementation of transformational concepts that enable the optimum and balanced utilization of airside and landside (i.e., terminal and intermodal transportation) components at national, regional, and local levels. The growth of the airport system will incorporate factors of environmental, financial, and regional sustainability.



Flexible Airport Facility and Ramp Operations - provide the ability to reallocate or reconfigure the airport facility and ramp assets to maintain acceptable levels of service that will accommodate increasing passenger and cargo demands. This includes changes in operational requirements, through infrastructure development, predictive analyses, and improvements to technology (e.g., automation and DSS) and procedures.

Airport concepts and capabilities needed to improve airport operations are distinct from surface ATM concepts and capabilities. With PNT capabilities, advanced ATM procedures and technologies will improve the operational capacity and efficiency of existing airport runways and surface operations. For example Performance-Based Navigation (PBN) provides VFR-equivalent operations during IMC on closely spaced parallel runways. On the airport surface, synthetic vision, moving maps, and automated alert and de-confliction systems will provide safe navigation of aircraft and Ground Support Equipment (GSE) during low-visibility conditions. Chapter 2 provides additional information on ATM capabilities.

3.2 AIRSIDE OPERATIONS

Airside operations encompass activities that take place on an airport’s runways, taxiways, aircraft parking aprons (whether adjacent to passenger terminals, cargo buildings, aircraft maintenance facilities, or GA facilities), and airside service roads. These activities include

⁶ Supporting airports include small hub, non-hub, and non-primary commercial service and general aviation airports in congested metropolitan areas.

1924 aircraft movements between parking areas and runways, as well as the movement of ground
1925 service equipment (GSE), operations vehicles, emergency vehicles, snow removal equipment,
1926 and construction equipment.

1927

1928 Key elements of NextGen include enhancement of safety and efficiency of aircraft and ground
1929 vehicle movements on the airport surface. Key stakeholders accomplish these objectives through
1930 the utilization of net-centric infrastructure resulting in significantly improved SSA. The results
1931 will improve emergency response, enhance airfield maintenance activities, expedite snow
1932 clearance, accelerate aircraft and pavement deicing, reduce the impact of other weather
1933 phenomena such as lightning and fog on airport operations, and improve asset and resource
1934 management.⁷

1935

1936 These enhancements will affect a broad spectrum of stakeholders, many of which will need to
1937 invest in enabling technologies and capabilities to realize benefits. Stakeholders include airport
1938 operators, passenger and cargo airlines, pilots, dispatchers, other aircraft operators (military,
1939 business, and GA), fixed-base and corporate facility operators, and third-party GSE operators.
1940 The FAA, which has ground traffic control responsibilities within airport movement areas, third-
1941 party ramp control providers and terminal operators, and airport contractors are also important
1942 stakeholders.

1943

1944 The sections below describe how planned improvements are expected to enhance airside
1945 operations.⁸

1946

KEY NEXTGEN TECHNOLOGIES—AIRPORT & AIRSIDE

Enhanced airside surveillance enabled by either ADS-B or local-area multilateration

Integrated, collaborative surface traffic management/gate management tools

Moving map displays for aircraft cockpits and airside ground vehicles

Single, authoritative sources of airport geospatial, weather, air traffic, and surface traffic data coupled with integrated data sharing capabilities that enable immediate sharing of these authoritative data with all key stakeholders operating on the airside

Improved weather prediction capabilities, particularly with respect to icing, precipitation, low-visibility, and lightning

3.2.1 Enhanced Airside Safety & Security

1948 NextGen will provide the information needed to enable improved situational awareness. This
1949 information will be processed by cockpit and in-vehicle displays of traffic information, moving
1950 maps, and other DST to provide pilots and ground vehicle operators with improved surface
1951 movement surveillance capabilities. Airport Operations Centers (AOC), and FOC will also have
1952 access to this information fed by surface surveillance systems (multilateration, ADS-B, and/or
1953 surface radar) these displays will provide stakeholders (controllers, dispatchers and operators)

⁷ For additional discussion of NextGen's net-centric concept of operations, please refer to Chapter 4. Similarly, additional discussion of the shared situational awareness services, including several that would provide airside operational benefits, can be found in Chapter 5.

⁸ Challenges associated with realizing these and other airport-related NextGen operational improvements are described in Section 4.5.

1954 with a real-time picture of the locations of other vehicles and aircraft on the ground, even in
1955 poor-visibility conditions. Enhanced surveillance and communications provide proactive alerts
1956 to pilots and ground vehicle operators, enabling them to take action to avoid runway incursions
1957 and surface collisions.

1958 Enabled in part by net-centric system architecture, both FAA Air Traffic and airport operations
1959 staff will be provided with real-time information about runway, taxiway, navigational aid, and
1960 lighting system status. Data sharing capabilities will enable the status of these facilities to be
1961 automatically communicated to pilots and aircraft dispatchers via electronic Notices to Airmen
1962 (e-NOTAMs), reducing the need for voice communications and the associated potential for
1963 transcription errors and lags between observations and reporting of airfield conditions.

1964 When reporting weather phenomena, particularly snow or ice, net-centric architecture facilitates
1965 the sharing of data to include runway friction, aircraft braking action, and precipitation
1966 accumulation collected by a variety of systems and/or stakeholders. This data may come from
1967 aircraft, ground-based systems, in-pavement sensors, weather systems, or field observations.

1968 In the event of an accident or incident occurring within the airside environment, communications
1969 and surveillance capabilities provide first responders with accurate real-time information
1970 regarding incident location, and aircraft details (e.g., aircraft type, interior configuration,
1971 passenger manifest, hazardous materials carried). In addition, recommended response strategies,
1972 facilitated by net-centric architecture and data sharing capabilities, will be provided directly to
1973 first responders and distributed among other parties involved in incident response such as
1974 support, emergency management center(s), and investigative authorities.
1975

1976 The data collected by surface surveillance and other systems can be archived and analyzed to
1977 identify potential safety risks before they result in incidents or accidents. The mining and
1978 analysis of such data will help improve the effectiveness of airport SMS.
1979 Airports will use various credential verification, access control, random measures and
1980 surveillance systems to safeguard aircraft parking areas, fuel farms, and other sensitive terminal
1981 airside areas, based on assessed risk. These measures include surface movement tracking,
1982 employee and vehicle access control, perimeter intrusion detection, Closed Circuit Television
1983 (CCTV), behavioral pattern analysis and InfraRed surveillance systems. Security sensor data will
1984 be shared with and used by a security operations center as part of airport NCO. Support software
1985 applications ensure data is proactively evaluated in real time to identify security risks and when
1986 able, address them before incidents occur.⁹

1987 **3.2.2 Improved Airside Operational Efficiency Especially in Non-Movement Areas**

1988 Another key objective of airside enhancements is improved efficiency of aircraft and ground
1989 vehicle mobility in the airport movement areas (runways and taxiways) and within non-
1990 movement areas (aircraft parking areas and apron). GSE surface movements are monitored in
1991 real time via cooperative and non-cooperative surveillance. This enables proactive management,
1992 using net-centric infrastructure, to ensure smooth, efficient, and safe flow of vehicular traffic

⁹ Please refer to Chapter 6 for a more detailed discussion of the NextGen ConOps for airport security.

such as baggage carts, fuel trucks, catering vehicles, and other airport vehicles. GSE will be equipped to provide accurate navigation and alerts during low visibility conditions in order to remain clear of active runways and taxiways, and to maintain safe separation from aircraft.

4DT operations provide airlines, airport operators, and third-party terminal operators with information that can be used to make better dynamic gate assignments, reducing apron-area congestion and increasing gate utilization at common-use terminal facilities. Airline dispatchers, terminal ramp controllers, and FAA ground controllers will be able to manage departures in congested apron areas collaboratively, thereby minimizing delays associated with simultaneous or near-simultaneous pushbacks.

Furthermore, air traffic controllers will be able to build virtual departure queues while aircraft wait at their gates or parking positions with engines off, rather than building real departure queues on active taxiways. These virtual queues (commercial, corporate, GA, and military operations, coupled with the approved flight plan contract) will enable flexible/dynamic resequencing of departures in response to changing weather and air traffic conditions, thus reducing airfield congestion, associated aircraft emissions, and fuel burn. Shared surface situational awareness coupled with 4DT operations facilitates the rapid and accurate dispatch of GSE and ramp staff to service incoming aircraft and turn them more efficiently. While these capabilities will benefit airport and aircraft operators in all weather conditions, they will be especially useful when adverse weather or other factors disrupt regular operations.

3.2.3 Enhanced Airside Facility Management

NextGen promises to enhance airport operators' ability to manage their airside facilities, in both the day to day and far term operations. Sensors on the airfield will collect data such as weather and pavement conditions, and integrated systems will detect anomalies and hazards like wildlife and Foreign Object Debris (FOD). With integrated 4D weather information, resources will be better aligned with operational demand in order to reduce delays.¹⁰ Resource management assists airports with active monitoring of environmental conditions (noise, air quality, water quality, and wildlife hazards) which directly feed into the airport operations center and reduces the need for time-consuming and labor-intensive inspection activities.

Net-centric geospatial information systems provide airport operators and other stakeholders with a common picture of airport facilities. Acting as a single authoritative source for information regarding facility physical, maintenance, and operational characteristics, these geospatial information systems will benefit a variety of users including airport planners, engineers, and maintenance and operations professionals. These systems will also provide essential information to airspace procedure designers, pilots, vehicle operators (via moving map displays), wildlife managers, and others. This same rich graphical data can also be used by emergency responders through enhanced moving maps.

Surface surveillance systems and the secondary surveillance information they provide (e.g., aircraft operator, aircraft type, time of operation) are leveraged by airport operators to facilitate

¹⁰ Please refer to Sections 4.3 and 5.4 of this document for more detailed discussions of the NextGen ConOps for airport-related weather tools.

2035 aeronautical revenue collection, to better manage aircraft gates and parking positions
2036 (particularly common-use facilities). Aircraft operators and the third-party terminal and facilities
2037 operators use this information to better manage their operations and facility utilization, especially
2038 at common-use terminal facilities.

2039 **3.2.4 Enhanced Airside Maintenance**

2040 The aforementioned geospatial information systems, married with infrastructure monitoring
2041 systems, assist airport operators in understanding their infrastructure management needs and
2042 permit targeted and timely maintenance and operations activities. Remote pavement, lighting,
2043 and marking system sensors will help apprise airport maintenance staff of issues before they
2044 result in the loss of mission-critical facilities (e.g., runways, approach lighting systems) and will
2045 help airport operators prioritize maintenance activities. The ability to track and analyze
2046 maintenance performance, combined with other support management systems, allows airport
2047 operators to cost effectively implement maintenance and service delivery.

2048 **3.2.5 Enhanced Winter Operations**

2049 During significant winter operations, airside resource management systems provide guidance for
2050 scheduling, prioritizing, and actively managing de-icing/anti-icing operations for both aircraft
2051 and airport surfaces. Winter weather forecasts and their impacts on surface conditions will be
2052 provided to resource management systems to inform decisions regarding deployment of
2053 treatment crews with optimal strategies to keep runways and taxiways clear and serviceable.
2054 Using advanced technologies, ground equipment and landing aircraft will more accurately
2055 measure runway friction. These friction measurements are automatically disseminated using
2056 NCO to aid landing aircraft in calculating landing distance.

2057 Predictive weather capabilities, icing sensors, and continuously monitored deicing/anti-icing
2058 holdover times will be used to modify 4D-trajectories and maintain smooth flows of traffic on
2059 the ground and in the air despite deicing procedures. Improved deicing/anti-icing technologies
2060 will be used to expedite deicing processes and reduce delay. Surface management systems,
2061 enabled by improved surface surveillance, are used to manage airport, airline, and fixed-base
2062 operator deicing facilities, equipment, and materials more effectively, matching aircraft that need
2063 to be deiced with available resources. Improved predictive weather capabilities and holdover
2064 time estimates, coupled with effective 4DT management, reduce the use of deicing and anti-icing
2065 chemicals by “right-sizing” the quantity of chemicals used during primary deicing, and reducing
2066 or eliminating the need for secondary deicing. This minimizes the harmful impacts of these
2067 fluids upon water quality. Sensors automatically detect pollution thresholds in local waterways
2068 allowing the airport operations center to take necessary actions, including diversion of used
2069 deicing/anti-icing fluids to storage for later treatment. Aircraft and surface deicing product usage
2070 are automatically monitored for reporting, mitigation, and compliance with environmental
2071 goals.¹¹

¹¹ Please refer to Chapter 7 for a broader discussion about how NextGen systems will address airport environmental goals and objectives.

2072 **3.2.6 Surface Data Availability and Management**

2073 The capabilities discussed above will require common, shared access to critical operational,
2074 geospatial, maintenance, and weather data. Without open access to this data across stakeholders,
2075 many of the benefits that will come from stakeholders' SSA of airside conditions will not be
2076 realized. For this reason, it will be essential for the FAA, airport operators, airlines, and other
2077 stakeholders to enact policies and procedures that facilitate the open exchange of this data, and
2078 standardize industry practices for collecting, sharing, and managing this data. These policies,
2079 practices and procedures will need to take into consideration data ownership, facilitation and
2080 sharing of data, and how stakeholders pay for the processing, analysis, and distribution of this
2081 data.

2082 **3.3 TRANSFORMED LANDSIDE AND PASSENGER TERMINAL OPERATIONS**

2083 More people and cargo will be moving through landside areas at airports, including passenger
2084 terminal buildings and ground access to get to and from an airport. Accordingly, effective airport
2085 resource management systems can enhance passenger flow management and connections to
2086 intermodal ground transportation.

2087 **3.3.1 Landside Resource and Passenger Flow Management**

2088 With the aid of net-centric infrastructure and services, airport resource management systems
2089 assist airport operators in the synthesis of real-time information and proactive management of
2090 resources in anticipation of near-term events, typically in an hourly or daily time frame. Landside
2091 functions also benefit, including terminal passenger flows, security screening status, parking, and
2092 airport curb status.

2093 Efficient passenger flows in airport terminals are important so that congestion, queues, and
2094 baggage do not impede passenger movements. Passenger (and other airport customer) flows are
2095 impacted by signage (e.g., Flight Informational Display Systems [FIDS]/Common Use Terminal
2096 Equipment [CUTE]), public transportation, regional transportation, parking, conveyance
2097 systems, terminal space layouts (including gates, concessions, and restrooms), airline business
2098 models, and marketing. In addition, changes to security protocols may create bottlenecks, thus
2099 impacting the ability of a passenger terminal to meet their needs and goals.

2100 To ensure smooth passenger flow management, coordinated information is broadcast to users,
2101 including current status and forecast for security wait, Customs and Border Protection (CBP)
2102 processing, and flight status. Although these systems exist today, they are not sufficiently
2103 synchronized to facilitate passenger flows. NextGen provides open information standards for a
2104 centralized, wireless-enabled system to disseminate passenger flow information at key airports to
2105 include ground transportation connectivity, weather, delays, parking availability, and check-in
2106 times within a single network.

2107 3.3.2 Passenger Processing and Security

2108 Advances in common-use systems continue existing trends toward automated issuance of
2109 boarding passes (whether paper or paperless) and faster processing of passengers. As discussed
2110 in Chapter 6, the Security Service Provider (SSP) is responsible for regulating, managing, and/or
2111 implementing new and transformational technologies and procedures to ensure system security
2112 using IRM. Typically, a departing passenger is able to arrive at the airport curb, get a boarding
2113 pass and check baggage (as needed), clear security screening, and be at the gate within 30
2114 minutes.

**2115 3.3.3 Off-Airport Passenger and Baggage Processing Enabled through Integrated Trip
2116 Tracking**

2117 An enterprise service provides for integrated trip tracking of baggage and passengers that
2118 adheres to industry-defined standards of service, reliability, maintainability, and universal access.
2119 The system supports tracking of passenger and baggage information (e.g., Radio Frequency
2120 Identification [RFID]), synchronization, itinerary/handling information, remote check-in, and
2121 security assurance. The system does not transfer passengers and baggage between venues, but
2122 supports the continuous tracking and availability of the plan, intent, and current locations of
2123 passengers and their baggage. An open information standard enables the transfer of passenger
2124 baggage (e.g., a passenger renting a car from a rental car company picks up the luggage at the
2125 rental car rather than at baggage claim).

2126 The Remote Terminal Security Screening (RTSS) facility provides added value to conducting
2127 full-spectrum screening of both passengers and bags, as described in Chapter 6. Then, a secure
2128 ground transport system transfers cleared passengers and bags to the sterile portions of the
2129 airport terminal. Alternatively, passengers transport self-tagged bags with RFID from off-airport
2130 terminals (that do not conduct security screening) to the airport and then air carriers accept the
2131 bags for transport prior to the passenger security screening. Depending on their specific needs,
2132 airports are able to adapt off-airport terminals of varying capabilities into their operations.

2133 The passenger and bag tracking system decentralizes passenger processing and allows bag
2134 processing to be conducted in an out-of-the-way area of the airport, if appropriate. This increases
2135 capacity, reduces check-in time, reduces personnel requirements, and enables tracking. Both
2136 bags and passengers are known entities, allowing 4DT aircraft departures in a more reliable
2137 manner. Passengers and bags are treated as information monitored by the passenger remotely
2138 (e.g., via mobile phone or handheld device). Demands on aircraft operator check-in personnel are
2139 reduced, as is space in the terminal for check-in. Passenger baggage is routed through an
2140 industrial sorting center to deliver either to the terminal or to the passenger's final destination
2141 (bus, train, hotel, etc.).

2142 3.3.4 Intermodal Ground Access

2143 Intermodal ground access is needed for air services to connect with ground transportation within
2144 each regional system to provide more efficient flow. Passengers have a variety of options,
2145 including public rail and bus transit, taxicabs, shuttle services, and private automobiles. The

2146 integration, of reliable information on intermodal ground access into a passenger's itinerary, aids
2147 in determining the best method of travel to and from the airport. The developments of
2148 intermodal transportation systems linked to airport ground access are an important component
2149 for making regional airport systems viable.

2150 Inclusion of intermodal links in this ConOps is not meant for funding or program
2151 implementation, but rather to highlight the need for airports to work with their communities to
2152 integrate airport and landside access/transportation planning. Because most passengers and cargo
2153 access the airport via the roadway system, increasing activity at an airport puts additional
2154 pressure on the regional road network. Moreover, intermodal transportation improvements are
2155 needed to support off-airport passenger and baggage processing.

2156 **3.4 TRANSFORMED AIRPORT DEVELOPMENT**

2157 Long-term planning and infrastructure development will enable the U.S. airport system to
2158 accommodate increased operational demand while maintaining a high level of service.

2159 **3.4.1 Airport Preservation**

2160 The United States must preserve a diverse network of airports throughout the nation in the best
2161 interest of an efficient national air transportation system. This includes all types of airports,
2162 inclusive of major air carrier airports and smaller, supporting airfields that act as relievers and
2163 regional airfields. All are vital for the future; however, many airports are at risk from
2164 encroachment or closure, and preservation of these resources is needed.

2165 Today, airports provide communities with a fast and efficient gateway to the domestic and
2166 international air transportation system. Many companies consider proximity to an airport a key
2167 reason for locating their facilities, including proximity to smaller airports that have sufficient
2168 infrastructure to support business jet operations. This will become even more apparent as air taxi
2169 operators using VLJ business models come into operation during the next decade.

2170 Supporting airports are also a vital resource during emergencies. Emergency response activities
2171 are often staged out of smaller airports, including responses to natural disasters such as
2172 hurricanes and wildfires. Without efficient airport access, emergency response services would be
2173 more constrained.

2174 The sustainability of existing airports is critical to the future growth of communities and to the
2175 nation's air transportation system. Planners envision increased use of supporting airports as a
2176 critical component to increasing total system capacity and thereby accommodating increasing
2177 demand. With the deployment of new precision approaches to most airfields, enabled by satellite
2178 navigation technologies and Required Navigational Performance (RNP), access to supporting
2179 airports becomes safer and more reliable. Increasingly, aircraft operators make maximum use of
2180 the existing infrastructure at supporting airports to avoid congestion and higher costs at major
2181 airports. New and emerging aircraft, including UAS, V/STOL, supersonic aircraft, and
2182 commercial space vehicles, as well as the ever-changing needs of the military require the support
2183 of a diverse network of airports. Where appropriate, increasing the utilization of existing and
2184 new joint-use facilities provides for improved civil access to the NAS.

2185 The primary threats to airport preservation are incompatible land use encroachment, conversion
2186 to non-airport uses, lack of sustainable capital and operating finance mechanisms, and lack of
2187 community support. Land use encroachment and development has long been a concern to airport
2188 operators and users. Accordingly, advocacy and sponsorship of the airport by local businesses,
2189 users, and the community is important for long-term preservation.

2190 With respect to land use, a new airport preservation program will enhance the sustainability of
2191 at-risk airports. In coordination with the National Plan of Integrated Airport Systems (NPIAS),
2192 at-risk airports would be identified via input from users, airports, and others with interests in
2193 airport preservation. States, airports, and Metropolitan Planning Organizations (MPO) would be
2194 partners in the implementation and success of the program. The FAA would participate in
2195 identifying and protecting critical airport infrastructure without changing airport operator
2196 responsibilities and state and local determination of land use. In addition to airport advocacy and
2197 fostering community support for airports, the program would seek to align federal airport
2198 programs toward the goal of long-term airport preservation.

2199 In addition to Airport Layout Plans (ALP), which are a required component of airport master
2200 planning, long-term maps (i.e., 20-year maps that coincide with comprehensive planning
2201 standards) of the surrounding environs, including airport protection surfaces, existing and future
2202 noise levels, and safety zones would be prepared for airports that participate in the program.
2203 Airport programs under 14 Code of Federal Regulations (CFR) Part 150 and Environmental
2204 Management Systems (EMS) would be aligned with the Airport Preservation Program in the
2205 interests of protecting land use compatibility, preventing encroachment, and enhancing
2206 environmental sustainability. A robust obstruction evaluation process and comprehensive maps
2207 of airport protection surfaces (i.e., 14 CFR Part 77 and Terminal Instrument Procedures
2208 [TERPs], as applicable) would help prevent new structures from exceeding height restrictions,
2209 and thus constrain instrument approach access to airports during inclement weather. Depending
2210 on the state enabling legislation for land use decisions, the long-term mapping could be
2211 integrated into airport overlay zoning in order to curtail new development with the potential to
2212 affect airport preservation or future expansion plans.

2213 Through intergovernmental agreements, information on proposed land use development actions
2214 within the long-term mapping (e.g., issuance of building permits, zoning amendments, and
2215 comprehensive plan updates) would be shared with airports, local governments, MPOs, state
2216 aviation agencies, and the FAA. This information sharing could assist with problem
2217 identification and aid in building consensus on development actions. For example, participating
2218 organizations could have the opportunity to review and comment on the development actions for
2219 suitability with airport plans, federal grant assurances, community interests, and the long-term
2220 sustainability of the NAS. Potential recommendations on the proposed development actions
2221 could include consent/approval, disapproval, or a recommendation to amend the plan to include
2222 easements, noise mitigation, and disclosure requirements. The jurisdiction seeking to approve the
2223 development plans would respond to the comments and provide their reasons for acceptance,
2224 rejection, or amendment. Depending on the governing laws of the state and local jurisdictions,
2225 varying legal remedies could then be available.

At a regional level, the identification of former military bases (e.g., as part of the Base Realignment and Closure process) that have potential civilian aviation uses could continue to be an important component in enabling aviation growth. In heavily developed regions, these former military bases may be the only realistic option for expanding regional airport access and capacity. The conversion of suitable former military bases to civil aviation use is facilitated through integrated, long-term regional planning that identifies future applicable aviation uses for the facilities. As previously mentioned, a new Geographic Information System (GIS)-based enterprise service will permit integrated obstruction analyses inclusive of the current 14 CFR Part 77 and TERPS obstruction criteria as well as the protections needed for air carrier one engine inoperative takeoff performance criteria, dynamic RNP, and other advanced flight procedures. By making the obstruction analysis process more robust, builders and the FAA are able to evaluate proposals and alternatives thoroughly and efficiently. As a result, airports and aircraft operators are protected from obstructions that impact approaches and capacity, thus aiding in the preservation of airports.

3.4.2 Catalysts for Airport Development Actions

While long-term development planning is an important tool for identifying potential infrastructure development projects, specific catalysts are needed to move projects from the planning stage to implementation. Historically, new gates and terminal layouts were built to accommodate widebody aircraft, regional jets, and hubbing operations. Airfield construction, including terminals, new runways, and runway extensions has been done in response to specific localized needs.

More recently, new security procedures such as the need for in-line baggage screening have driven further changes. In an era when airport security has become a national priority, airports have been able to accommodate new and evolving infrastructure needs in order to guarantee aviation security. Metrics relating to aircraft quantity, size, performance, capacity, landside access, and level of service must be used to evaluate potential solutions to improve airport infrastructure. Interpreting the various metrics with an understanding of how changes might affect the entire network of airports is paramount. For example, solutions implemented at a number of major airports may cause significant and negative impacts at supporting airports, or vice versa. To achieve balance, NextGen will recognize the diversity of airports and work to integrate the national planning process with site-specific facility planning, financial planning, environmental sustainability, and regional system planning. This approach, combined with benchmarking, market analysis, effective policy, operational procedures, and technology will help identify the appropriate airport infrastructure necessary to develop an integrated airport system and thus meet their goals and objectives.

3.4.3 Efficient, Flexible, and Responsive Airport Planning Processes

Solutions to critical airport issues need to be balanced against other aviation metrics such as aircraft operations, passengers, capacity, safety, level-of-service standards, landside access, and environmental goals. For each of these, the NAS will require a clear image of different airport types and the domino effect that could ensue as a result in major aviation policy changes. For example, solutions that are implemented at a number of large airports may cause significant and negative impact on smaller airports, or vice versa. To achieve the proper balance, the future

2268 airport system will require the ability to integrate multiple planning processes and analyses to
2269 determine the appropriate airport infrastructure necessary to develop the future integrated airport
2270 system plan.

2271 Processes that encompass traditional master, financial, and environmental planning activities are
2272 integrated into a single, comprehensive architecture that enables more efficient, flexible, and
2273 responsive planning. NextGen goals are integrated into the planning process, as are ANSP
2274 coordination activities that are needed to ensure the successful implementation of airport
2275 improvements (e.g., so that airport planning actions take into account airspace constraints).
2276 Regional considerations such as the specific roles of airports within a system, availability and
2277 need for intermodal transportation links, and the comprehensive plans (including land use) of
2278 local jurisdictions are key factors in successful airport planning efforts. By integrating these
2279 diverse activities into a complete process that is efficient, predictable, and transparent, oversights
2280 are reduced and capabilities are enhanced. Effective public involvement is also critical to
2281 ensuring that the community is aware of and can support airport infrastructure development.

2282 FAA-supported finance mechanisms are available to support integrated planning processes as
2283 well as coordination actions for the ANSP. For major airports, planning will occur on an
2284 ongoing, annual basis in connection with Capital Improvement Programs (CIP) and performance
2285 management activities in order to identify long-term gaps and emerging trends and respond
2286 appropriately. A continuous, integrated planning process supports environmental streamlining
2287 activities by speeding the identification and dissemination of airport data as well as improving
2288 data comprehensiveness and quality. The continuous planning process also supports the EMS
2289 process discussed in Chapter 7.

2290 The impact of aviation on the surrounding environment is a critical study element in the
2291 development of airport infrastructure. As air traffic grows, airports will operate in a more
2292 environmentally sustainable and energy-efficient manner to prevent environmental degradation.
2293 Sustainability and environmental management measures will be incorporated into proposed
2294 facilities, programs, and procedures. Post-implementation evaluation of actions will be an
2295 essential component of the planning process, so the actual benefits of new infrastructure can be
2296 quantified and compared to the planned estimates. This supports a lesson-learned function in
2297 planning activities in order to identify successful project strategies and valuable lessons learned.
2298 EMS will be used to monitor and review and to provide information to adapt and improve. The
2299 end result is an efficient planning process that integrates airport, financial, environmental, and
2300 regional planning activities as the process evolves to satisfy the emerging infrastructure needs
2301 and constraints of the NAS.

2302 **3.4.4 Regional System Planning**

2303 Increased support at a national planning level will (1) promote intermodal and ground
2304 transportation initiatives directly related to using alternate airports, (2) manage demand among a
2305 system of airports, and (3) protect airports from non-compatible development while also
2306 recognizing the land use needs of communities in the vicinity of airports. In the interest of long-
2307 term sustainability, airports and local governments shall work together to improve compatibility
2308 and to protect airport and community resources, including off-airport environmental and

2309 community planning issues. Comprehensive, integrated regional system plans are critical to
2310 achieving these objectives.

2311 Planning for airport systems, intermodal transportation, and land use are integral components of
2312 comprehensive regional system plans:

- 2313 • Airport system planning includes activities to determine the role of each airport within a
2314 system, estimate aviation demand, determine infrastructure needs, and provide for
2315 environmental management.
- 2316 • Intermodal transportation planning includes activities for highway, high-speed bus, and
2317 rail (including light, heavy, high-speed, and freight) connections between airports, RTSS
2318 facilities, central business districts, regional transportation arteries, and residential areas.
- 2319 • Land use planning includes activities to integrate airport compatibility standards for
2320 aircraft noise and obstructions into the comprehensive plans implemented by local
2321 jurisdictions, while also considering the development, revenue, and demographic needs
2322 of the communities.

2323 Through regional system plans, airport operators can take a more active role in local land use
2324 planning by being involved in the development, review, and implementation of comprehensive
2325 plans used to manage local land use. Proactive use of multiple land use management tools,
2326 including disclosure requirements, conventional and overlay zoning, land banking, and
2327 development rights will also be important. Efforts to prevent new obstructions to air navigation
2328 (e.g., radio towers) from constraining aircraft performance and instrument arrival/departure
2329 procedures at an airport will also be part of the regional system plan.

2330 In order to manage interdependencies, multiple components will be integrated into the regional
2331 system planning process. Through consideration of the needs, constraints, and goals of aircraft
2332 operators, communities, and other stakeholders, the regional system plan will serve to integrate
2333 decision making for airports, intermodal transportation, and land use. The regional system plan
2334 would provide guidance on the specific activities undertaken by local jurisdictions and airport
2335 operators for ground transportation and land use development. Potential environmental impacts
2336 and benefits will also be assessed, using appropriate metrics and impact criteria for noise, air
2337 quality, water quality, and other effects. Primarily, regional system planning would be most
2338 critical for major metropolitan regions with multiple airports and a diverse transportation
2339 network.

2340 While regional system planning is not a new concept, it will become vital for success when
2341 addressing the challenge of increased aircraft operations, passenger, and cargo demand.
2342 Specifically, airport planning processes will need to incorporate regional components, including
2343 regional policy decisions. Airports will provide local and regional transportation planning
2344 agencies (e.g., MPOs) with proposed development plans (including master plans) for review and
2345 comment. In addition, airports and airport operators will collaborate with surface transportation
2346 agencies in their planning efforts so that airport ground access needs can be considered in the
2347 context of the overall regional transportation planning and programming process.

2348 Federal, state, and local roles in regional coordination and decision making will be defined.
2349 Appropriate policy guidance and finance mechanisms will be identified and made available to
2350 support regional system planning and intermodal infrastructure development. A better
2351 understanding of how market and non-market mechanisms affect the choices made by aircraft
2352 operators to serve specific airports is necessary so that regional needs can be better forecasted
2353 and incorporated into decision making.

2354 **3.4.5 Flexible Terminal Design**

2355 Design guidelines for Airport Passenger Terminal Buildings will be implemented to facilitate the
2356 flexible integration of new technology and procedures (e.g., advanced passenger and baggage
2357 processing, remote check-in, and security), and assist in the development of new terminal layouts
2358 and signage that promote smooth passenger flows during busy periods. With flexible terminal
2359 designs, changes in processing technologies and security screening requirements can be
2360 accommodated in a terminal envelope that enables rapid reconfiguration of the building to meet
2361 ongoing needs. Available infrastructure would support common-use facilities such as gates,
2362 ticket counters, kiosks, and information systems. Note that the common-use infrastructure is not
2363 intended as a federal mandate; each airport and its users will determine gate allocation based
2364 upon its specific needs and factors related to efficiency, cost, and availability.

2365 New terminal designs will increasingly incorporate provisions to support energy and resource
2366 conservation, including green design and technologies.

2367 **3.4.6 Optimized Airfield Design**

2368 Airfield design planning and engineering standards will be optimized to take full advantage of
2369 ATM improvements. Standards are needed to guide the design of new infrastructure, deployment
2370 of sensors and NAVAID equipment, and support operations at airports by new types of aircraft.

2371 **3.4.6.1 Closely Spaced Parallel Runway Operations**

2372 Procedures and equipage that permit independent aircraft operations to/from closely spaced
2373 parallel runways (i.e., with smaller separation standards than those in use today) maximize the
2374 capacity of existing infrastructure. In terms of airfield design, reducing separation between
2375 parallel runways needed for independent aircraft operations reduces the land needed for runway
2376 development. One of the major limitations to new runway development is the lack of available
2377 land to develop new runways at high-traffic airports, especially in dense metropolitan areas.
2378 Specific parallel runway separation standards are a function of ANSP procedures; the
2379 development and implementation of new standards will have a substantial effect on airfield
2380 design and capacity.

2381 **3.4.6.2 Airport Geographic Information Services**

2382 The airport operator has an important role in providing accurate and up-to-date GIS data. Today,
2383 the lack of ready access to accurate and up-to-date airport surface GIS data is a significant issue
2384 with existing automation systems.

2385 High-quality airport data and information will be available in a centrally managed,
2386 comprehensive repository. For example, the flight hazard/obstacle review process can be
2387 automated through distributed GIS with information on Part 77/ TERPS surfaces and obstacles.
2388 This data can be used to support safety assessments and hazard mitigation tracking. Airport
2389 layout plan documents would be available in a central repository accessible through a managed
2390 process (e.g., an airport map database). Other components, such as noise and emissions data,
2391 land use, historic aircraft trajectory data, and completed studies would also be available in the
2392 central repository. As appropriate, these systems would be developed in GIS-based formats.

2393 ***3.4.6.3 Obstacle Measurement and Data Distribution***

2394 Mature airborne and satellite-based obstacle identification and measurement techniques
2395 supplement present-day ground survey practices. Accuracy tolerances and required clearance
2396 criteria currently added to obstacle locations and heights are reduced or eliminated, thereby
2397 allowing airspace designers to develop Instrument Approach Procedures (IAP) with the lower
2398 minimums. Obstacle data are readily available through a Web-enabled distribution system using
2399 GIS technologies. This achieves substantial increases in capacity because it increases access to
2400 the airport during low ceiling and visibility conditions.

2401 ***3.4.6.4 Airport Protection Surfaces***

2402 Aircraft performance characteristics that increase levels of safety, combined with advanced
2403 instrument procedure design criteria, allow for reductions in obstruction clearances and
2404 associated protection areas currently required for both ground and satellite-based aircraft flight
2405 procedures. This allows arriving aircraft to use lower ceiling and visibility minimums when
2406 using IAPs during inclement weather, thereby increasing access to the runway and increasing
2407 overall capacity because operations are not constrained due to inclement weather. Lower ceiling
2408 and visibility minimums also permit more aircraft to depart airports during adverse weather.

2409 Consideration needs to be given to alleviating recent changes to precision obstacle-free zones
2410 and final approach surfaces that have had dramatic impacts to airports with displaced landing
2411 thresholds.

2412 ***3.4.6.5 Sensors***

2413 New sensors and sensor arrays will be deployed at airports. Sensors may be needed in the
2414 runway environment for the active detection and dissipation measurement of wake vortices,
2415 which will enable reduced aircraft separation during conditions when wake turbulence is not a
2416 hazard. Advanced weather sensors are also deployed to airports, including sensors that provide a
2417 detailed picture of the atmosphere along the airport approach and departure paths in order to
2418 detect the varying conditions that may affect flight operations and wake vortices. Airport design
2419 standards incorporate placement criteria, non-interference zones, maintenance requirements, and
2420 other necessary considerations for the sensors.

2421 ***3.4.6.6 NAVAIDS***

2422 The transition to satellite-based IAPs frees up airport surface movement areas previously
2423 constrained because of ground-based navigation systems (e.g., instrument landing system [ILS]-
2424 critical areas). Less ground-based radio navigation infrastructure is required to support IAPs than

2425 is used today with ILS and other systems. Therefore, ILS-critical areas and other zones designed
2426 to protect instrumentation from interference are less of a constraint. This facilitates the efficient
2427 movement of aircraft on the airfield.

2428 **3.4.6.7 Other Design Factors**

2429 Airports have improved runway safety areas that meet applicable FAA airport design standards
2430 in order to support potential aircraft overruns. Where sufficient land is not available or improved
2431 runway safety areas are not practical, alternative mechanisms to prevent overruns will be
2432 implemented (e.g., Engineered Material Arresting System [EMAS]).

2433 Unique infrastructure needs for UAS, V/STOL, space planes, and other new flight vehicles are
2434 incorporated into airport design standards. A new collision risk model may permit use of larger
2435 aircraft in existing object-free zones.

2436 While efforts to increase runway capacity are vital, the ground and gate capacity of the airfield is
2437 also critical. The ground interactions between GSE, people conveyance systems, and aircraft on
2438 the apron and taxiways, as well as aircraft crossing runways, are a significant constraint to
2439 capacity. For example, high-density operations may require end-around taxiway systems and
2440 other changes to airfield layout in order to minimize the need for runway crossings by taxiing
2441 aircraft. At night, the apron space required for overnight parking of aircraft also increases
2442 substantially. The reduction of ground movement delays and congestion due to constrained
2443 airport infrastructure is an important component, as is providing sufficient gate capacity.

2444 Ultimately, no single strategy will increase the capacity of the NAS and airports. Rather, a
2445 thorough analysis of the multiple components in the system and their interactions will provide
2446 the optimum combination.

2447 **3.4.7 Airport Congestion Management**

2448 Congestion management programs at major airports may be used to manage short-term situations
2449 where demand exceeds the available capacity of the airport infrastructure. A combination of
2450 regulatory and market-based mechanisms could be used to balance the competing needs of
2451 airport users/stakeholders seeking access, for airports to provide a reasonable level of service,
2452 and for the ANSP to mitigate the ripple effects of localized congestion throughout the NAS.

2453 Congestion management is discussed in this ConOps in an effort to track the ongoing policy
2454 discussion regarding airports where infrastructure development and ATM capacity
2455 improvements are not likely to be sufficient to meet future demand (e.g., New York LaGuardia).
2456 Accordingly, congestion management is a policy issue rather than a specific concept; however,
2457 the policy choice made regarding congestion management will likely affect some airports.
2458 Congestion management also differs from cooperative ATM concepts that seek to meter traffic
2459 in and out of congested airports rather than manage airport access.

2460 Congestion management programs rely on market-based mechanisms to allocate aircraft operator
2461 access to high-demand facilities. Congestion management without any regulatory mechanisms
2462 could affect the viability of service from small communities to airports in major economic

2463 centers and thus convenient access to larger markets and the connecting destinations those hub
2464 airports can provide. If congestion management increases the cost of airport access, flights from
2465 certain smaller communities to major economic centers may not be economically sustainable.
2466 Alternatively, the market-based incentives could shift flights to/from smaller cities to off-peak
2467 times, which may not be conducive to convenient travel schedules. Such adverse effects could be
2468 mitigated through specific measures within a congestion management program specifically
2469 designed to protect small markets that economically rely on this access.

2470 In addition to short-term situations, consideration may be given to allowing airports to impose
2471 peak-period user fees that will both help manage congestion and bring increased revenue to the
2472 airport for use in modernization investments and other improvements that will assist in meeting
2473 growing activity levels. Existing federal statutes require revenue neutrality, preventing the
2474 airport from transferring increasing user fee surpluses beyond the airport or regional airport
2475 system if they generate revenues that significantly exceed airport costs. Changes to federal law in
2476 this manner could encourage greater infrastructure investment that would benefit the NAS.

2477 Within a congestion management program, the roles and responsibilities of federal, state, and
2478 local government decision makers as well as the airport operator will need to be clearly
2479 delineated. As discussed previously, the disposition of revenue over and above airport needs will
2480 need to be determined, including the potential use of this revenue to support the economic
2481 sustainability of airport infrastructure.

2482 3.5 CHALLENGES TO NEXTGEN AIRPORTS

2483 The diversity of airports is an important consideration under Next Gen. Each airport is a unique
2484 operating environment, reflecting the diversity of the local communities that sponsor them, to a
2485 far greater extent than the analogous airspace structures. Different airport layouts, constraints,
2486 and procedures pose unique challenges to achieving and maintaining efficient operations at peak
2487 capacity without sacrificing safety.

2488 Key factors that will drive airport development and operations through 2025 include the
2489 following:

- 2490 • Major airports that are at or near capacity today may not be able to reasonably expand to
2491 support future demand. This could drive development of other airports in congested
2492 metropolitan regions.
- 2493 • Supporting airports will expand by promoting higher levels of service to both aircraft
2494 operators and their customers, potentially pushing integration into the hub-and-spoke
2495 system and stimulating changes in the airline hub business models.
- 2496 • Congestion and delay may drive some airport users' decisions to opt for greater certainty
2497 and predictability for air transport services via regional airports with
2498 (scheduled/nonscheduled) nonstop service or other modes of transportation.
- 2499 • Sufficient intermodal transportation networks must be developed to link airports with
2500 population and business centers. People and cargo must be able to get to and from the
2501 airport in a predictable and efficient manner.

- 2502 • Federal, state, and local agencies must evolve to support the effective governance of
2503 airport operations and regional considerations, given the many stakeholders who have
2504 vital interests in a successful airport system.
- 2505 • New aircraft technology will allow long-range flights with medium seating capacity, thus
2506 promoting point-to-point service to smaller airports.

2507 Beyond traditional airline operations, new service offerings are expected from operators of
2508 V/STOL aircraft, VLJs, and space vehicles of various kinds (e.g., orbital and suborbital space
2509 vehicles and point-to-point suborbital space planes). These new services are expected to continue
2510 to drive growth in GA and nonscheduled air transport operations as an alternative to scheduled
2511 air carrier travel.

2512 Newly developed V/STOL aircraft (e.g., tiltrotors) could increase service within large
2513 metropolitan areas and thereby promote the development of small-footprint airports designed
2514 specifically to serve these operations. Insertion of increased V/STOL operations into major hub
2515 airports requires careful design to ensure that conventional aircraft operations are not negatively
2516 affected.

2517 VLJs offer the potential to make business jet travel more efficient and cost effective. While the
2518 viability and sustainability of the VLJ air taxi business models have yet to be proven, VLJs could
2519 substantially increase air service options, especially in communities that currently have limited
2520 service. Ultimately, the airport infrastructure needed to accommodate VLJs already exists at
2521 most airports, because the aircraft have the capability to operate from shorter runways (i.e., 3,000
2522 to 4,000 feet). With the expansion of satellite-based IAPs to additional runways, the related
2523 infrastructure requirements such as approach/runway light systems, SNT, and ANT, increases.
2524 Conversely, VLJ use at major airports and in congested airspace could exacerbate delay levels as
2525 a result of increased aircraft operations and the complexities of managing air traffic with
2526 dissimilar airspeeds and wake turbulence separation requirements.

2527 Commercial space flight (suborbital, point-to-point, and orbital) offers considerable potential for
2528 the next 20 years. Some types of space vehicles could be interoperable with conventional fixed-
2529 wing aircraft in order to make the best use of existing infrastructure. This could help the
2530 integration of Commercial Space Transportation (CST) operations into congested airspace and
2531 airports. Alternatively, CST operations could be conducted at dedicated or dual-use spaceports
2532 remote from the busy facilities in metropolitan areas and utilize various kinds of airspace
2533 reservations for their transition through the NAS. Although suborbital flights may ultimately
2534 bring about a radical change in how people travel between continents and the time required to do
2535 so, the impact on airport infrastructure is unknown.

2536 At airports with significant scheduled air carrier service, the physical and functional layout of
2537 passenger terminals is likely to evolve in response to changes in passenger processing, aircraft
2538 size and geometry, remote data access and sensing, information sharing, and high-occupancy
2539 intermodal transportation connections. The trend for passenger check-in at locations outside the
2540 airport, such as at home, via mobile phone, and at hotels will continue and expand as remote
2541 terminals support off-airport passenger and baggage processing. The infrastructure needed to
2542 support security screening should decrease as these processes are integrated and refined.



4 Net-Centric Operations

2543

2544

4.1 INTRODUCTION

2546 Net-Centric Operations (NCO) is the application of network methods and technologies to
2547 improve, transform, expedite or provide for the exchange of information throughout the NAS.
2548 NCO encompasses the ability to store, transport, and retrieve air transportation-related
2549 information and data between providers and consumers on a reliable, scalable, flexible, and
2550 secure enterprise network. This is accomplished through the provision and management of
2551 infrastructure resources to sustain normal operations and service level agreements. As illustrated
2552 in Figure 4-1, NCO is the realization of a real-time, globally interconnected network
2553 environment, which incorporates infrastructure, systems, processes, and individuals to enable an
2554 enhanced information sharing approach to aviation transportation.

2555

Figure 4-1 NextGen Information Stakeholders

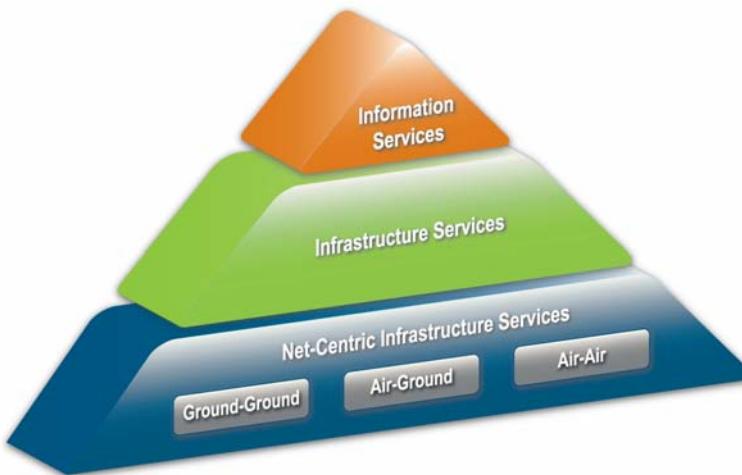


2556

2557 A foundational and transformational component is the employment of a net-centric environment
2558 for exchanging air transportation-related information. There are two key components of the net-
2559 centric environment: Infrastructure Services and Information Services. Infrastructure is the
2560 framework for sharing information, while services direct the information to the authorized users

2561 who need it. Examples of information provided by NCO include flow/trajecory information,
2562 advisories/alerts, surveillance, real-time NAS configuration, aviation security reports, and
2563 weather reports/forecasts. Figure 4-2 depicts Information Services and Infrastructure Services
2564 relationships and displays the underlying physical network infrastructure on which both operate.

2565 **Figure 4-2 Net-Centric Infrastructure Overview**



2566
2567 The network infrastructure provides an integrated, global network that will incorporate three
2568 segments: (1) a ground segment, (2) an air-ground segment, and (3) an air-to-air segment. The
2569 ground network is the backbone of the net-centric environment, carrying inter-facility data
2570 throughout the network. The ground network will also act as an essential support for the air-
2571 ground segment, by transporting data to and from the appropriate ground radio equipment. The
2572 air-ground network will carry data from ground systems to the cockpit and vice versa. This
2573 critical segment of the network enables the delivery of real-time surveillance, weather data, and
2574 relevant security information to the cockpit and enables the negotiation of trajectories and
2575 separation responsibility contracts between pilots and controllers. The air-to-air segment will
2576 build on existing technologies (such as ADS-B), allowing aircraft to share critical real-time
2577 positional information along with, surveillance and weather data.

2578 Infrastructure Services are focused on providing and managing connectivity linkages and
2579 channels. These services handle such tasks as access control, transport of basic data, bandwidth
2580 provisioning, as well as network monitoring and diagnostics. Information Services on the other
2581 hand are built on top of the Infrastructure Services and are focused on providing relevant content
2582 to appropriate users. Information Services are tailored to implement the various specific needs
2583 within the aviation transportation system. Many types of services are expected to include:
2584 delivery of weather data from a ground database to the cockpit, sharing security data between
2585 agencies, carrying voice data between facilities, and sharing trajectories between aircraft.

2586 The key to a successful net-centric environment is the establishment of secure, interoperable
2587 enterprise networks for the FAA, Department of Defense (DOD), Department of Homeland
2588 Security (DHS), and Department of Commerce (DOC). These enterprise networks comprise a
2589 combination of physical infrastructure and Infrastructure Services. Along with information

sharing standards, they facilitate the exchange of information necessary to achieve many of the needed operational improvements. Once these enterprise networks are established and capable of interoperating, they must be interconnected in order to achieve NextGen capabilities.

Despite having the enterprise-level connections and infrastructure in place, without defined processes for those using the capabilities, the net-centric environment is not likely to be fully realized. Therefore, formalization of an institutionalized sharing process is necessary to provide the policies, processes, and accountability required to ensure that stakeholders integrate information distribution into their planning and daily operations.

Integrated NextGen Information is expected to focus in the areas of network-enabled information sharing, aircraft data communications links, infrastructure management services, and improved surveillance and air domain awareness. These capabilities require widespread access to secure, accurate, and timely information as well as the means to share this information securely among the operational entities.



Integrated NextGen Information - provides authorized aviation stakeholders timely, accurate, and actionable information (e.g., weather, surveillance, aeronautical information, operational and planning information, and position, navigation and timing information), shortening and improving decision cycles situational awareness using a net-centric environment managed through enterprise services that meets the information exchange requirements of the NextGen stakeholder community.

2610

4.2 TRANSFORMED NET-CENTRIC OPERATIONS

NCO provides a robust, globally interconnected network environment in which information is shared in a timely and consistent way among users. This includes associated applications and platforms during all phases of aviation transportation efforts. By securely interconnecting distributed users and systems, net-centricity provides a robust, resilient, efficient, and effective information-sharing environment, enabling substantially improved situational awareness and shortened decision cycles. Information and data are contained in an integrated, interoperable system with the necessary Quality of Service (QoS) that enables stakeholders to meet their objectives and achieve operational efficiency. Over time, the net-centric environment responds iteratively to provide infrastructure capabilities of increased capacity to meet our needs.

The net-centric environment works together with automation to implement “intelligent” system capabilities. For example, wherever possible, these capabilities include the ability to automatically capture all relevant data about components of the air traffic operations environment, including aircraft, baggage, expendable supplies, aircrew, controllers, ground-handling equipment, gates, and passengers. The system then provides this information to authorized recipients to help them make timely decisions.

In the net-centric environment, information flows freely from ground to aircraft, ground to ground, and aircraft to aircraft, as needed. Commercial network protocols and topologies are employed with seamless integration between the aircraft, the ground, and the rest of the information network, making information available to users at an unprecedented rate. Network

2631 connectivity is applied throughout the air domain and provided from the ground up to all flight
2632 altitudes, and includes oceanic and polar regions.

2633 Moreover, a robust network among the stakeholders' infrastructure permits information sharing.
2634 This allows organizations, operational groups, and systems throughout the NAS to collaborate in
2635 a seamless information infrastructure, providing insight for the following areas:

- 2636 • Air navigation service, airport, and flight operations
- 2637 • SSA
- 2638 • Compliance and regulation oversight
- 2639 • Security, safety, environmental, and performance management services

2640 Integration of these operations and services requires an adherence to open standards that
2641 maximizes their interoperability across domains. Additionally, this integration requires the net-
2642 centric environment to provide services that enable secure discovery of and collaborative use of
2643 this information for the purpose of effective and efficient operation of the air transportation
2644 system.

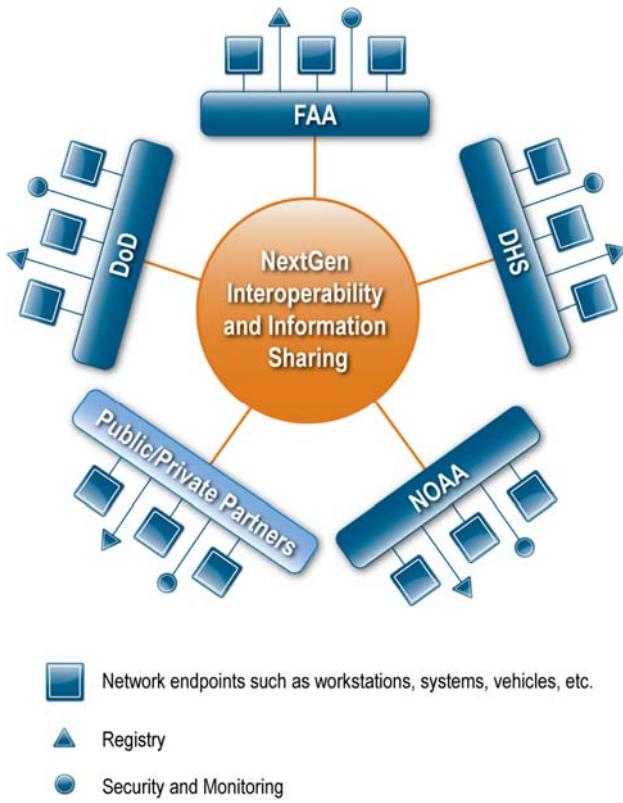
2645 **4.2.1 NextGen Enterprise Network**

2646 As illustrated in Figure 4-3, the NextGen Enterprise Network is composed of the stakeholders'
2647 enterprise networks, joined together and interoperating by protocol conformance and connective
2648 infrastructure. This is a "logical" view of the system. Each stakeholder enterprise can encompass
2649 components of all various types in the aviation community: ground-based computers and
2650 workstations, airborne cockpit systems, and so on. The NextGen Enterprise Network provides
2651 the following features:

- 2652 • **Uniform Connectivity Protocols.** Communications transport provides sufficient and
2653 dynamic addressing of all network nodes with secure and assured end-to-end connectivity
2654 throughout the air transportation enterprise.

2655

Figure 4-3 NextGen Enterprise Network



2656

- **Data Availability.** Data registries and discovery mechanisms between entities (government, commercial, private, and international organizations) allow for data sharing in a push/pull and publish/subscribe environment between authorized COI.
- **Content Understanding.** Metadata tagging and federated search allow the contents of data to be understood.
- **No Single Point of Failure.** A distributed information environment ensures information reliability, quality, and no single point of failure.
- **Information Assurance.** Secure exchange of information includes access controls, trust relationships, and associated policies and mechanisms to provide appropriate access to information by authorized users. Maintenance of information assurance across security levels and domains is a critical feature of the NextGen Enterprise Network.
- **Quality of Service (QoS).** Data and information are provided at well-known, monitored levels of quality (e.g., data rates, bandwidth, and latency). The performance characteristics of these services are digitally captured and maintained in service descriptions and Service Level Agreements (SLA).

2672 4.2.2 Network Management & Security

2673 Infrastructure Services include the network management functional areas of fault, configuration,
2674 accounting, performance (including QoS), and security as well as higher-level functions such as

2675 services management. The emphasis is on an integrated and holistic approach to enterprise
2676 network management.

2677 To facilitate information sharing, NextGen must include a cyber security approach that
2678 safeguards the information within acceptable trusting relationships between the information
2679 suppliers and consumers. Agreement on a trust relationship is critical to making the information
2680 available to authorized members within the large stakeholder community. Information sharing is
2681 flexible and adaptable to circumstances and stress experienced by the system over time.
2682 Information access rules are continuously updated depending on the circumstances or events at
2683 the time.

2684 The success of information sharing depends on constituent trust that information is properly
2685 protected, that it is not misused or mishandled, and that recipients have a valid need for the data.
2686 In turn, this trust depends on applying information assurance policies, designs, rules, and
2687 information systems hardware and software that can be tested and certified and on the ability and
2688 willingness of the participants to effectively implement and manage their security
2689 responsibilities.

2690 **4.2.3 Air-Ground Networking**

2691 Key to enabling an agile, scalable airspace environment and its management is the deployment
2692 of a fully capable aircraft data communications link. This data communications transformation
2693 enables aircraft to collaborate with Enterprise Services. This collaboration includes sharing real-
2694 time spatial information, identification, weather, security, and operational status for all aircraft.
2695 The operational information sharing also includes PNT and airport status. Furthermore, the data
2696 communications link enables the real-time negotiation of 4DT collaboration between ANSP and
2697 pilots. This robust aircraft data communications link also enables a digital voice link to the
2698 aircraft. This link enables the flight deck to communicate with all necessary collaborative
2699 decision makers and operational entities. Utilizing advanced communications technologies and
2700 spectrum allocations—which supersede current limited-capacity data links—there is sufficient
2701 bandwidth to support all data types necessary (including audio, graphics, and video) with
2702 appropriate QoS (including flight-critical data service).

2703 With the transformed role of flight management improved data communications are critical for
2704 safe and efficient flight operations. Flight deck automation and avionics supports flight crew
2705 decision making by providing real-time operational information to the ANSP. Data
2706 communications, rather than voice communications, are the primary means of communication
2707 between the flight deck and the ANSP for airspace that requires such capability for clearances
2708 and 4DT amendments. Voice communications, however, will continue to be used to
2709 communicate with less-equipped aircraft. Additionally, voice communications will provide a
2710 means to handle exceptions, such as emergencies and conflict resolutions.

2711 Aircraft communicate via airborne networking capability based on the level of required
2712 performance in the airspace they are transiting (equipage policy). The goal is to utilize the
2713 optimal combination of assets for communication. It may be aggregated data channels from
2714 airborne nodes, space, or ground stations. Every aircraft is a node on the network, providing
2715 information connectivity and relaying information when needed. This network is based on

2716 commercial network technologies and provides connectivity for all types of aircraft, from large
2717 commercial jetliners to business jets, helicopters, and GA.

2718 As indicated above, there is increased sharing of improved common data between the flight deck,
2719 operator, and ANSP. In airspace where data communications will be available but not required,
2720 information exchange can take place with data communications for participating aircraft to
2721 provide an operational advantage. Common data includes ATC clearances, current and forecast
2722 weather, hazardous weather warnings, notices to airmen (NOTAM), updated charts, current
2723 charting, special aircraft data, and other required information. Data communications also include
2724 weather observations made by the aircraft that are automatically provided to the ANSP, weather
2725 service providers, and flight operators for inclusion in weather analysis and forecasts. Each of
2726 these data communications is managed by Required Communications Performance (RCP)
2727 standards through an open and integrated network architecture. This network shares information
2728 in standard formats, using harmonized services that connect information systems to users.
2729 Typical users include the ANSP, agencies, carriers, aircraft, airport operators, service providers,
2730 and general users. By securely interconnecting distributed users and systems, net-centricity
2731 provides an information-sharing environment that enables substantially improved situational
2732 awareness and shortened decision cycles. This ultimately results in significantly more efficient
2733 and valuable new operational capabilities.

2734 **4.3 INTEGRATED NEXTGEN INFORMATION**

2735 Integral to the NextGen vision is the creation of an environment that facilitates quick and reliable
2736 communication and sharing of information, thus improving situational awareness and shortening
2737 decision cycles within the air transportation system. This capability ensures a robust, scalable,
2738 resilient, secure, and globally interconnected net-enabled environment in which information is
2739 timely and consistently shared among authorized aviation users, systems, and platforms. This
2740 capability reduces the number and type of interfaces and systems required to maximize
2741 interoperability and increase collaboration across missions. The seamless flow and integration of
2742 information between air and ground components reduces unnecessary redundancy of data and
2743 facilitates information sharing targeted to the appropriate decision makers. The improved
2744 predictability and access to accurate and timely information allows users to optimize system
2745 resources and communicate status changes or other essential information to all those who need to
2746 know.

2747 **4.3.1 Transformed Network-Enabled Trajectory Management (TM)**

2748 NCO is vital to the envisioned improvements in TM. Where many TM processes are manual
2749 today, NCO facilitates the transition to efficient, automation-assisted digital processes.

2750 The transition from voice-based communications to data communications is a key element. For
2751 trajectory information (and all other routine exchanges), data is the preferred method of
2752 communication between the flight deck and controllers. Voice will still be used in cases of
2753 emergency such as safety of flight (e.g., a situation where a conflict or midair collision is
2754 imminent and voice will preclude an incident), or as part of a backup procedure should data
2755 communications experience unforeseen interruptions.

2756 Data communications are central to TBO. This includes, the use of 4DTs (pushback and taxi
2757 inclusive) for planning and execution on the surface, automated trajectory analysis and
2758 separation assurance, and aircraft separation assurance applications that require flight crew
2759 situational awareness of the 4DTs and short term intent of surrounding aircraft.

2760 **4.3.2 Transformed Network-Enabled Collaborative Capacity Management**

2761 The transformations in the delivery of ground, air-ground, and ANSP facility services are
2762 fundamental enablers of the flexibility necessary to respond to demand in an affordable and
2763 timely manner. Flexible infrastructure supports changing user needs and provides cost-effective
2764 services that are scaled up and down as needs change. This ensures that the service providers and
2765 the information (e.g., flight data, surveillance, weather) are readily available when and where
2766 needed.

2767 **4.3.2.1 Dynamic ANSP Resource Utilization**

2768 A key transformation enabled by the communications network and associated net-centric
2769 applications is the ability to provide surveillance, communications, and flight data management,
2770 including automation-assisted coordination, to any service provider regardless of its physical
2771 location. When coupled with a more flexible air-ground communications network, this
2772 transformation supports the optimal daily deployment of resources and assets. Airspace and air
2773 traffic can be assigned without regard to a fixed infrastructure constraint, allowing traffic load
2774 sharing across the ANSP workforce on a seasonal, daily, or hourly basis.

2775 The networking capability also provides a robust contingency/business continuity capability.
2776 Information systems facilitate monitoring infrastructure health and remote maintenance to
2777 maintain service availability and automatically alert the community about the status of assets.
2778 Losses of ANSP personnel workstations due to equipment outages or catastrophic events can be
2779 mitigated by reassigning ATM and the supporting infrastructure to remaining workstations
2780 across the NAS.

2781 Because the flexible ground and air-ground communications networks negate the requirement for
2782 proximity of ANSP facilities to the air traffic being managed, facilities are sited and occupied to
2783 provide for infrastructure security, service continuity, and best deployment and management of
2784 the workforce. This includes co-locating several operational domains (e.g., en route transition,
2785 terminal) within a facility as well as staffing NextGen towers. The SNT and any needed ANSP
2786 personnel need not be geographically located at the airport. Productivity gains may be achieved
2787 by allowing ANSP personnel to service multiple airports according to traffic density.

2788 Drivers for dynamic reconfiguration include the need for efficient traffic flows, the effects of
2789 weather, personnel (staffing), SNTs, and facility or equipment outages, to mention a few.
2790 Regardless of the catalyst, the CNS systems each respond when dynamic reconfiguration
2791 procedures are executed.

2792 **4.3.2.2 Flexible ATC Communications Boundaries**

2793 Another key transformation is that air-ground voice communications are no longer limited by the
2794 assigned frequency-to-airspace sector mapping. This allows greater flexibility for developing and

2795 using airspace/traffic assignments in all airspace. Communications paths, including both voice
2796 and data, are controlled by an intelligent network. Communications between the ANSP and the
2797 flight deck are established when the flight is activated and are maintained continuously and
2798 seamlessly. This capability is linked to the flight data management function so that the system
2799 automatically manages who has authority to interact with the flight deck based on the type of
2800 agreement being negotiated or information being exchanged. Labor-intensive transfers of control
2801 and communication are automated. Data and voice communications are automatically transferred
2802 in the flight deck as the aircraft moves between Air Route Traffic Control Centers (ARTCC).

2803 **4.3.3 Transformed Network-Enabled Collaborative Flow Contingency 2804 Management**

2805 NCO brings specific benefits to FCM. The NextGen Enterprise Network provides the
2806 stakeholders (FAA, Air Carriers, DOD, etc.) with a highly available, flexible medium for
2807 collaboration. FAA and DOD can negotiate in near real-time the allocation of SAA and such
2808 regions, based on current and projected demand. Air carriers and the FAA can collaboratively
2809 tackle issues such as daily weather impacts, route availability, and operational preferences. The
2810 capabilities are even more transformative when not only individuals representing these
2811 stakeholders can collaborate, but their *automation systems* can increasingly carry out the work of
2812 collaboration for them in even more timely and efficient ways.

2813 **4.3.4 Transformed Network-Enabled Weather**

2814 The NextGen Enterprise Network provides the essential “plumbing” (infrastructure) for
2815 consistent, timely weather information to pervade the aviation community. As participants in
2816 weather are particularly diverse and distributed, NCO is particularly important in this domain.
2817 NextGen Net-Centric Infrastructure provides the connecting tissue that holds together the “4D
2818 Weather Cube,” including weather sensors, databases, forecasting systems, and human
2819 participants. It also delivers the Cube’s products to automation systems and stakeholders
2820 throughout NextGen.

2821 **4.4 AIR DOMAIN AWARENESS**

2823 In order to achieve the ideals of improved decision making and efficient operations, stakeholders
2824 must have the right information at the right time. This is especially true in the domain of aviation
2825 surveillance. Not only does SSA play a key role in security but also improves operations across
2826 the NAS. The Net-Centric Infrastructure is vital to conveying and delivering real-time air domain
2827 information in various forms and ways to the users that need it.

2828 PNT services prevent the constraint of routes and flight paths to fixed positions. Using
2829 complementary aircraft systems that provide RNP and RNAV, PNT services allow aircraft to
2830 navigate precisely along the most efficient route that meets the needs of the user, the ANSP, and
2831 the overall NAS. NextGen will be more flexible, responsive, and unconstrained using satellite-
2832 based and ground-based systems that provide universal PNT services that accurately and
2833 precisely determine current location, orientation, and desired path; apply corrections to course,
2834 orientation, and velocity in order to attain the desired position; and obtain accurate and precise

2835 time anywhere on the globe within user-defined parameters. With this information, aircraft can
2836 apply the necessary corrections to maintain a desired position and path.

2837 Accurate and precise PNT services also enable improved surveillance capabilities, reduced
2838 separation standards, and the synchronized operations. The decommissioning of current ground-
2839 based navigation systems, along with the improved operations from enhanced PNT services, will
2840 result in significant cost savings. The NextGen vision requires surveillance services that improve
2841 the accuracy, latency, integrity, and availability of surveillance information. Surveillance
2842 information is envisioned to be provided through a net-centric infrastructure, allowing all
2843 certified users, including the ANSP, security providers, and flight operators the appropriate level
2844 of access to data in a secure manner. This improved precision, access, and timeliness of
2845 information will allow distributed decision making on a real-time basis during normal
2846 operations, abnormal events, or system-wide crises. Integrated surveillance services will also
2847 provide many new functions, including full air situational awareness, en route de-confliction, and
2848 support for self-separation capabilities. Integrated surveillance services will also reduce
2849 separation standards and provide precise 4DT information, including aircraft intent and
2850 conformance monitoring. Additionally, to minimize the risk of collisions and maximize the use
2851 of airspace, comprehensive tracking of aircraft and vehicles operating on the airport surface,
2852 within the ANSP responsible airspace, and in sovereign airspace will be provided. This
2853 comprehensive tracking would enable flexible assignment of multiple surveillance sources to any
2854 operational position at any time, and further allow more flexibility in assigning airspace to each
2855 position as needed to support distributed decision making. Surveillance services also will help
2856 provide adaptive, flexible spacing and sequencing of aircraft on the ground and in the air.



5 Shared Situational Awareness Services

2857
2858

2859
2860

5.1 INTRODUCTION

2861 Situational awareness (SA) involves being aware of one's surroundings to understand how
2862 information, events, and actions impact goals and objectives. Sharing timely, accurate, relevant
2863 and actionable information among users is known as SSA. SSA is fundamental to the vision for
2864 providing Integrated NextGen Information, Air Domain Awareness, and Weather Information
2865 for safe and efficient NAS operations. Integrated information sharing depends on the availability
2866 of SSA information services. Information services are dependent upon established infrastructure
2867 services, accomplished by the processes and applications that constitute the function.
2868 Information services allow authorized user-subscribers to access necessary information through a
2869 standing request in an automated and virtual fashion using established protocols and standards.
2870 This access concept is what facilitates the vision of the future—distributed data for decision
2871 making. Moreover, the transformation of the air transportation system is fully dependent upon
2872 accessible and shared information.

2873 The Integrated NextGen Information capability will provide SSA and enable authorized
2874 stakeholders to exchange, discover, and consume timely and accurate information (e.g., weather;
2875 surveillance; PNT; aeronautical; and geospatial) in a decentralized, distributed, and coordinated
2876 environment. Through available enterprise services provided by NCO, an environment is
2877 provided where trusted stakeholder partnerships, policies, and standards (to include data conflict
2878 resolution) enhance decision making by improving SSA and dramatically shortening decision
2879 cycles.



2880 **Integrated NextGen Information:** Integrated NextGen information
2881 provides authorized aviation stakeholders with timely, accurate, and
2882 actionable information. This includes weather, surveillance and
2883 aeronautical information. It also includes operational and planning data,
2884 as well as position, navigation and timing information. This information
2885 shortens decision cycles and improves situational awareness using a net-
2886 centric environment, managed through enterprise services that meet the
2887 information exchange needs of the NextGen stakeholder community.

2888 **5.2 INTEGRATED NEXTGEN INFORMATION**

2889 **5.2.1 Integrated Surveillance Information**

2890 The federal government conducts surveillance operations to detect, validate, and characterize
2891 cooperative and non-cooperative air vehicles either before, or after they enter the NAS.
2892 Interagency partners, working as a team, need to improve how they ensure safe, secure, and
2893 efficient passenger and cargo operations in the NAS, while deterring, preventing, and defeating

2894 unauthorized or hostile air activities. This is only possible through better integration of all
2895 surveillance activities.

2896 Key attributes as well as an underlying strategy to improve surveillance capabilities include:

- 2897 • Maximize coverage of airspace from surveillance assets.
- 2898 • Maximize sharing of surveillance data and other relevant information through machine-
2899 to-machine interface and other techniques to reduce redundancy of action, minimize
2900 surveillance gaps, and ensure data accuracy between interagency partners.
- 2901 • Correlate and fuse disparate data to ensure interagency mission partners are able to
2902 display, discuss, and act on the same track regardless of specific system interface and
2903 display properties.

2904 Additionally, through advanced processing and utilization of net-centric information
2905 management services, mission partners:

- 2906 • Automatically confirm when they are looking at the same track
- 2907 • Access pre-flight information in a timely manner
- 2908 • Receive automated, in-flight updates on changes to key flight characteristics
- 2909 • Operate with increased confidence as a result of enhanced and shared track monitoring.

2910 **5.2.1.1 Shared Information**

2911 Shared surveillance information provides varied levels of integrity depending on the desired use.
2912 Situational awareness and wide area surveillance requirements differ from safety of life and
2913 weapons targeting information. Some of the following characteristics of shared information
2914 include:

- 2915 • **Provenance** – ensures the validity of the original data source and the chain of custody of
2916 subsequent processing of the data are known.
- 2917 • **Confidence** – ensures the accuracy of original and transformed data to meet established
2918 thresholds.
- 2919 • **Accessibility** - ensures dissemination of the data and information to be appropriately
2920 secure and compliant with policies, laws, directives or other regulations. Access to
2921 information must be based on appropriate processes, such as roles based access controls,
2922 and with the need to know.
- 2923 • **Consistency** - ensures algorithms for processing and analyzing data must meet standards
2924 for consistency among mission partners (e.g., tracker, coordinate system, and adaptation)
2925 to allow for SSA and CDM.

- 2926 • **Availability** - ensures a measure of the data present or ready for immediate use over
2927 time.
- 2928 • **Accuracy** - ensures data represents the actual value of the quantity being measured.
- 2929 • **Continuity** - ensures the time between data points are within required thresholds.

2930 In addition to surveillance sensor data and existing information sources, shared information
2931 includes flight intent and intelligence information. Information from maritime domain awareness
2932 and space domain awareness, and potentially UAS, could also be available for sharing.

2933 **5.2.1.2 Enabling Technologies**

2934 Refined, integrated aviation surveillance and geographic data are used by the public and by
2935 government Command and Control (C2) facilities to provide ATM security, defense, and other
2936 shared services. SSA among government partners is enabled by both access to shared air vehicle
2937 track data and data management services. It is also provided by the ability of C2 systems to
2938 publish and subscribe specific track and geographic air domain information. Additionally,
2939 enabling technologies include net-centric data distribution capability and service-oriented,
2940 aviation surveillance data exchange protocols which are developed by the aviation surveillance
2941 and intelligence COI.

2942 **5.2.1.3 Sensor Network**

2943 Net-Centric Infrastructure will deliver sensor data to facilities for subsequent automated
2944 processing. This network will have the appropriate class of service attributes, QoS, and
2945 communications protocols for delivery of the near-real-time sensor data. The network will
2946 protect information in a secure manner using appropriate means. Additionally, the outputs of
2947 existing federal surveillance sensors, not currently integrated, will be connected to the network
2948 as appropriate to ensure maximum advantage of their collective capabilities.

2949 **5.2.1.4 Shared Services**

2950 Automated processing of sensors and other surveillance relevant information will occur through
2951 shared services that provide for correlation, tracking, fusion, data reduction and other
2952 surveillance-specific transformations. Services will also be provided that are of a more general
2953 nature, such as information discovery and translation, and will be accessible through an
2954 enterprise network infrastructure. The specific identification of the shared services will be
2955 developed through a follow-on architectural effort.

2956 **5.2.2 Positioning, Navigation, and Timing Services**

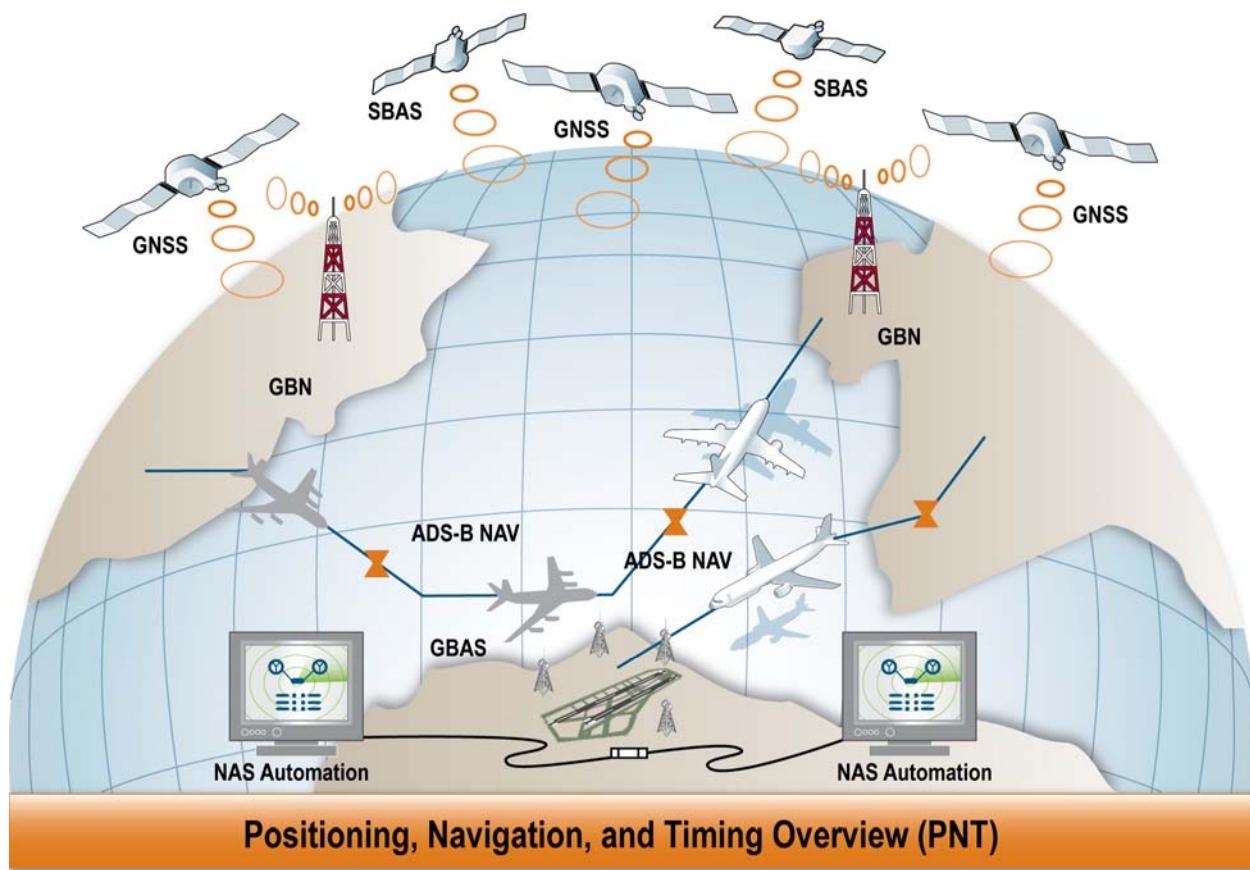
2957 PNT Services are a key component of the SSA NextGen vision. PNT services will provide the
2958 ability for an air vehicle to accurately and precisely determine its current location and orientation
2959 as well as its desired path and position. It provides aircraft with course corrections, orientation,
2960 and speed to attain desired position and time anywhere on the globe, within user-defined
2961 parameters. As illustrated in Figure 5-1, NextGen will rely heavily on PNT Services to
2962 implement and conduct many standard operations, as well as TBO and time synchronization.

2963 Aircraft navigation has long been constrained by the capabilities of ground-based NAVAIDs and
2964 routes that are tied to the physical location of these NAVAIDs. Historical reliance on ground-

2965 based NAVAID locations has also constrained airspace design. PNT Services enable RNAV as
2966 the standard method of navigation in the NAS. Further, PNT Services provide the foundation for
2967 PBN operations, including those operations that have a specified RNP requirement.

2968 Additionally, PNT Services enable enhanced aircraft surface operations, allowing aircraft to
2969 maintain separation from other aircraft, fixed infrastructure, and the various mobile elements of
2970 GSE found in the airport environment.

2971 **Figure 5-1 Positioning, Navigation, and Timing Overview**



SBAS: Satellite-based Augmentation System GBN: Ground-based Navigation
GNSS: Global Navigation Satellite System GBAS: Ground-based Augmentation System

2972

2973 PNT Services are ubiquitous. They enable operations at remote and sparsely equipped facilities
2974 that in today's NAS are currently incapable of being performed without the purchase and
2975 continuous maintenance of additional costly ground-based NAVAIDs.

2976 Finally, airspace design, including dynamic boundary and SAA, can readily be developed based
2977 on operational needs and geographic and environmental limitations, rather than the placement of
2978 ground based NAVAIDs.

2979 5.2.2.1 *Timing Services*

2980 Timing services provide a common, accurate, and precise data point for all users from a standard
2981 universal coordinated time. These timing services enable the precise synchronization of
2982 operations and the reduction of uncertainties associated with disparate timing sources.

2983 As NextGen moves toward a more net-centric approach to information dissemination, the need
2984 for precise timing services becomes inescapable. Air-to-air, air-to-ground, and ground-to-ground
2985 systems all require precise timing in order to communicate, coordinate and exchange
2986 information.

2987 5.2.2.2 *PNT Components*

2988 The primary system providing PNT Services is expected to be a GNSS. Users may also have
2989 operational needs that require a satellite-based augmentation system, such as the Wide Area
2990 Augmentation System (WAAS), or a ground-based augmentation system, such as the Local Area
2991 Augmentation System (LAAS). These systems provide increased accuracy, availability, and
2992 integrity to users of the service.

2993 Legacy navigation systems such as Distance Measuring Equipment (DME), Very High
2994 Frequency Omni-Directional Radio Range (VOR), and Non-Directional Beacon are incapable of
2995 meeting most of the positioning and navigational requirements, and none of the timing
2996 requirements. It is likely that these systems will have been divested, either through
2997 decommissioning or through release to state/and local authorities, or private entities, who desire
2998 to maintain such a capability for local use.

2999 5.2.2.3 *PNT Backup*

3000 In the absence of any other means of navigation, a loss of PNT services, due to either intentional
3001 or unintentional interference, would have varying negative effects on air traffic operations. These
3002 effects could range from nuisance events requiring a systematic restoration of capabilities, to an
3003 inability to provide normal ATC service within one or more sectors of airspace for a significant
3004 period of time. Although procedural separation methods would be used to maintain safety of
3005 flight, several solutions have been identified that could help mitigate the effects of a PNT service
3006 disruption:

- 3007
- 3008 • Equip user avionics to utilize the Global Positioning System (GPS) L5 civil frequency, as
3009 well as the legacy L1C/A frequency, in order to mitigate the impacts of the ionosphere
3010 and unintentional interference
 - 3011 • Modernize user avionics to integrate multiple PNT phenomenology, including inertial
3012 navigation systems (INS)
 - 3013 • Integrate GPS/inertial avionics anti-jam capabilities
 - 3014 • Maintain a minimal network of VOR, DME, and ILS facilities

3015 5.2.2.4 *PNT Summary*

3016 Nearly every aspect of NextGen requires PNT services. Flight planning, aeronautical information
3017 services, air navigation services, flight information services, GIS, weather information services,

3018 and surveillance all require high levels of precision and integrity from the provisioned PNT
3019 service. With PNT Services, a user (or COI)-determined integrated air picture provides valuable
3020 SSA to all users.

3021 **5.2.3 Aeronautical Information Services**

3022 Aeronautical information is uploaded, received, aggregated, and exchanged in a timely manner.
3023 Subscribers to the system include flight operators, airport operators, ANSPs, and other
3024 stakeholders. Aeronautical Information Services (AIS) include updates and aggregated
3025 information on:

- 3026 • Current performance requirements for airspace access and operation
- 3027 • SAA status and activity
- 3028 • Route information and performance metrics
- 3029 • System outages affecting GPS, WAAS, LAAS, and other NAVAIDs
- 3030 • Weather status, such as convective activity, winds aloft, and icing
- 3031 • Airport status information, including runway availability and planned long- and short-
3032 term activities affecting the airport, such as construction and snow removal
- 3033 • Definitional data for airspace boundaries, fixes, terminal procedures, runways, and other
3034 supporting information

3035 The system accepts information from both ground and airborne users, aggregates the
3036 information, and makes it available to subscribers. Aeronautical information is updated in real
3037 time and provided in a manner that allows users to understand the changes more readily.
3038 Additionally, the information is user-friendly and available in digital form (graphically or via
3039 digital text). The data is also machine-readable and supports automated processing of
3040 information for TBO.

3041 Aeronautical information services utilize GIS to provide users with the ability to access and
3042 update information about the physical locations of both fixed and mobile assets. This service
3043 provides information on assets such as physical facilities, airspace boundaries, airport survey
3044 information, and the locations of CNS infrastructure elements. To achieve this level of
3045 information exchange, all assets in the NAS are described in a common reference set (i.e., an
3046 earth-based coordinate system) to ensure comparability and interoperability across all
3047 applications. Further, to increase the efficiency of these comparisons, GIS users may employ a
3048 common indexing structure to support the development and exchange of asset information as
3049 well as query about overall asset inventories. The GIS manages current information, maintains
3050 historical information, and allows access to planned/desirable future capabilities. Under this
3051 structure, static elements (e.g., sectors, fixes, NAVAIDS, and radars) and dynamic elements
3052 (e.g., aircraft, weather, and TFRs) are referenced to latitude and longitude, and then indexed to a
3053 single hierarchical grid to speed comparisons. The design of the index supports high-resolution
3054 data and includes the time component necessary for projections and strategic planning. This

3055 capability supports the reconfiguration of airspace and airport assets to provide maximum use of
3056 the available capacity to meet traffic volume, while adjusting for weather or other constraints as
3057 they arise.

3058 GIS supports dynamic airspace boundary adjustments, TBO, interactive flight planning, and
3059 future DST operating in a collaborative environment of shared data. This service depends on the
3060 ability to describe, communicate, and manage the characteristics of airspace and other asset
3061 information (and their constituent elements) at increasingly finer levels of resolution. This
3062 increased precision and resolution supports decision making by the ANSP and also provides a
3063 basis for SSA for collaboration (such as cooperative ATM) among the ANSP, flight operators,
3064 and other stakeholders.

3065 **5.3 INTEGRATED AIR DOMAIN AWARENESS**

3066 Effective operation of the NAS, for civil aviation, national defense, and homeland security
3067 purposes, relies on accurate and timely airspace situational awareness. To meet national
3068 objectives, the federal government conducts surveillance operations to detect, validate, and
3069 characterize cooperative and non-cooperative air vehicles approaching or in the NAS. As
3070 previously mentioned, interagency partners, work as a team to ensure safe, secure, and efficient
3071 passenger and cargo operations in the NAS while deterring, preventing, warning, and, if
3072 required, defeating unauthorized and unwanted air activities.

3073 As illustrated in Figure 5-2, multiple departments and agencies have a need for aviation
3074 surveillance information to satisfy their often overlapping aviation-related roles and
3075 responsibilities. These agencies and their associated needs include:

- 3077 • Department of Transportation (DOT)/ FAA for providing separation services in the NAS
3078 and supporting aviation security
- 3079 • DHS for providing airborne and airport aviation security
- 3080 • DOD for defending airspace, executing air sovereignty and air defense missions, and for
3081 civil support and catastrophic event mitigation, as well as separation services in select
3082 areas
- 3083 • ODNI, on behalf of the intelligence community, for integrating all-source intelligence
3084 and supporting integration of intelligence and surveillance data to enable shared domain
3085 awareness among interagency partners
- 3086 • DOC for NAS surveillance and atmospheric information to generate weather forecasts
3087 and information on routine and hazardous weather

3088 The overlapping roles of these agencies create cross-dependencies for surveillance information
3089 produced by their own systems or data produced by other agencies. All agency partners can
3090 benefit from technologies that increase availability and management of high-quality surveillance
3091 data, including common data fusion, computer-assisted anomaly detection tools, common data
3092 standards, data exposure and sharing, and a tailorabile user-defined operational picture.

3093

Figure 5-2 Surveillance Overview

3094

5.3.1 Coordinated Security

Changes to the way federal, state, local, and tribal government agencies will use and share information are aligned with the guiding principles of the National Strategy for Aviation Security (NSPD 47/HSPD-16), which recognizes data integration and information sharing capabilities as central pillars of air domain security.

The Air Domain Surveillance and Intelligence Integration Plan specifically names detection, information sharing, and integration as guiding principles. These guiding principles inform the operational concepts for integrated air surveillance, which:

- **Inform** through the aggregation of all available flight-related information
- **Monitor** the NAS in service of both air traffic safety and preserve its security

National Strategy for Aviation Security

"The Nation must refine ongoing efforts to develop shared situational awareness that integrates intelligence, surveillance, reconnaissance, flight, navigation systems, and other aeronautical data and operational information. To ensure effective and coordinated action, access to air domain awareness information must be made available at the appropriate classification level to agencies across the U.S. Government, other local government actors, industry partners, and the international community."

- 3112 • **Detect** planned or actual anomalous and/or suspicious behavior within and approaching
3113 the NAS
- 3114 • **Identify and Locate** safety and security threats to the air domain
- 3115 • **Assess and Respond** to identified safety, security and defense- related threats

3116 **5.3.1.1 Detection**

3117 The FAA is envisioned to continue to maintain DOD/DHS-funded primary radar devices and
3118 tracking systems as well as its own Primary Surveillance Radars in terminal airspaces for some
3119 time to come. DOD, DHS, and FAA will continue to rely on these assets as a primary, but not
3120 sole, source for detecting anomalous and suspicious behavior, especially for non-participating or
3121 non-cooperative aircraft. The FAA would increasingly rely upon ADS-B out for ATM of
3122 commercial aircraft operating within the NAS. The increased accuracy of these ADS-B tracks
3123 provides significant benefits to equipped users through improved efficiency and priority
3124 handling. It also will eventually help support reduced separation standards for equipped aircraft
3125 and implementation of an automated system for detecting anomalous activity and alerting ATC
3126 operators and security partners of such activity. ADS-B tracking capabilities and long- and short-
3127 range surveillance radars, when combined with continuous, automated updating of ATM flight
3128 information and DHS risk assessments, will assist DHS, DOD, and law enforcement agencies to
3129 identify friendly participating commercial aircraft, thereby providing dedicated response actions
3130 to unauthorized or suspicious aircraft operating or attempting to operate within the NAS.

3131 **5.3.1.2 Information Sharing**

3132 Automation of information exchanges will accelerate ATM and air domain security decision
3133 making processes and also increase the confidence in which decisions are made. Today, this
3134 process must be handled through labor-intensive verbal or written communications. The ANSP,
3135 for instance, will have immediate access to any change made by DHS to a flight's risk profile,
3136 enabling its operators to assess the status and intent of most flights within controlled airspace
3137 quickly and confidently. Shared, automated, and immediate access to all pertinent pre-flight
3138 information and real-time aggregation and correlation of data feeds from surveillance systems
3139 will likewise provide DHS with the information it needs to make an accurate assessment of the
3140 security risk of any given flight.

3141 **5.3.1.3 Integration**

3142 For civil aviation, security, and defense operations, the integrated aviation surveillance services
3143 have to be anchored on three fundamental principles:

- 3144
- 3145 • Maximize operational benefits for all mission partners
- 3146 • Ensure safe, secure, and efficient operations in the NAS
- 3147 • Harmonize global aviation to move passengers and cargo freely

3148

3149 For civil, security, and defense operations, the target's size, speed, radar signature, and
3150 manned/unmanned status must be taken into consideration. Weather affects airborne operations
3151 and response; therefore, weather information must be incorporated accordingly. Accurate and
3152 timely aviation surveillance information, both cooperative and non-cooperative, is also crucial

3153 for efficient air traffic operations as well as for threat detection and assessment. Aviation
3154 surveillance is at the intersection of several key capabilities to include PNT, CNS, and TBO
3155 aircraft operations. The integrated aviation surveillance service will improve the ability and
3156 allowable time to support effective operational decisions for all mission partners for all
3157 surveillance-related operations, including ATM and security and defense operations.
3158

3159 **5.3.2 Domain Awareness**

3160 The *National Strategy for Aviation Security* and the supporting *Air Domain Surveillance and*
3161 *Intelligence Integration Plan* offer similar guidance, noting that “to maximize domain
3162 awareness, the Nation must have the ability to integrate surveillance data, all-source intelligence,
3163 law enforcement information, and relevant open-source data from public and private sectors,
3164 including international partners.” These documents direct partner agencies to synchronize
3165 surveillance efforts and integrate capabilities to persistently monitor, detect, identify, and track
3166 aerial objects within and outside the United States.

3167 Within the integrated surveillance environment, data from all surveillance sources, including
3168 cooperative and non-cooperative systems data, will be accessible and made available for
3169 operational display and data processing. Moreover, the integration of surveillance information
3170 from multiple sources, including classified systems, will provide real-time access to the
3171 information needed to deter and prevent threats before they enter U.S. airspace. Additionally it
3172 will identify, locate, assess and respond to threats that originate within U.S. airspace and allow
3173 the ANSP to conduct routine air traffic operations in a manner that supports both increased air
3174 traffic and flight safety.

3175 The net-centric environment will enable a user-defined operational picture so that each mission
3176 partner will be able to access, share, and display the required data needed to execute their
3177 mission, regardless of its origin. Air domain SA is achieved through access and exposure to
3178 multiple data sources and composite information fusion enabled by machine-to-machine
3179 interfaces and rapid data exchange.

3180 Aviation surveillance source data will be integrated, shared, and monitored by collaborative,
3181 mission-specific systems that will automatically detect and alert air domain security partners to
3182 the occurrence of anomalous activity in the NAS. Surveillance data will be augmented with other
3183 mission-related data such as air vehicle flight plans, clearances, risk levels, weather forecasts,
3184 and intelligence, which will be readily accessible through net-centric, information sharing
3185 services. Fusion of surveillance data and machine-to-machine interfaces will facilitate efficient
3186 and accurate coordination between operators, and reduce cost by optimizing communications
3187 paths.

3188 Totality of air domain awareness is dependent on the quality and completeness of surveillance
3189 coverage and information integration. The ability of aviation partners to share and access near-
3190 real-time information relevant to threat identification, monitoring, prevention, and response,
3191 based on net-centric SSA, enables and informs risk-based decision making.

3192 **5.4 INTEGRATED WEATHER INFORMATION**

3193 The primary role of providing weather information is to enable the identification of optimal
3194 trajectories that meet the safety, comfort, schedule, efficiency, and environmental impact
3195 requirements of all NAS users. Weather information is designed to integrate with and support
3196 decision-oriented products with automation capabilities that enhance user-safety with the NAS.¹²

3197 Weather information in the form of meteorological variables that are observed or forecasted
3198 (e.g., storm intensity, echo tops) must be translated into information that is directly relevant to
3199 NAS users and service providers. Therefore, this information is supported by a set of consistent,
3200 reliable, probabilistic forecasts, covering location (three-dimensional space), timing, intensity,
3201 and the probability of all possible outcomes, each with an associated likelihood of occurrence.

3202 Network enabled weather will serve as the integrated infrastructure core of weather support
3203 services and provide a single access approach to a common weather picture across the NAS.
3204 Additionally, network enabled weather will identify, adapt and utilize standards for system wide
3205 weather data formatting and access. Using network enabled capabilities, aviation weather
3206 information will be developed which can be directly and commonly accessed and integrated into
3207 DST. The virtual database will consolidate a vast array of ground-, airborne-, and space-based
3208 weather observations and forecasts, updated as needed in real-time, into a single, national—
3209 eventually global—picture of the atmosphere.

3210
3211 Weather information is collected by automated processes through merging observations, models,
3212 climatology, and human forecaster input. A network-enabled, four-dimensional weather data
3213 cube (4-D Wx Data Cube) ensures that accurate weather information is integrated into
3214 operational decision making. A subset of this 4-D Wx Data Cube, known as the 4-D Wx Single
3215 Authoritative Source (4-D Wx SAS), provides seamless, consistent, de-conflicted weather
3216 information for ATM decisions. The 4-D Wx SAS facilitates the integration of weather
3217 information directly into operational DST. The information is available to generate displays and
3218 for direct integration into automated DSS. The 4D weather capability provides the basis of the
3219 common picture and consists of weather attributes organized by latitude, longitude, altitude,
3220 time, and probability components (x, y, z, t, plus probability). Observations from surface sources,
3221 aircraft, and satellites are incorporated into the common weather picture.

3222 The update frequency of weather information is commensurate with the need to respond to
3223 rapidly changing circumstances. For instance, airspace structural changes are better customized
3224 in response to changing weather conditions (e.g., realigning sectors to conform to a line of
3225 thunderstorms). Also, these weather capabilities allow rapid notification (automation-to-
3226 automation) of changing weather situations to strategic and tactical decision makers.

3227 As with enhanced communication of weather information to ground-based automation systems
3228 and human users, weather data communications to the flight deck involve both “subscribe” and
3229 “publish” dissemination of critical information. Aircraft may request specific weather

¹² For a more detailed examination of the role of weather information in NextGen, see the NextGen Weather Concept of Operations (http://www.jpdo.gov/library/Weather_ConOps.pdf).

3230 information impacting their flight route, while broad area weather advisories and warnings are
3231 issued to all affected aircraft when safety-critical changes occur.

3232 Network-enabled aircraft also become active participants in collection and transmission of
3233 weather information. Observations are transmitted to ground-based systems for integration with
3234 other weather sources and to other aircraft. Aircraft operating in performance airspace act as
3235 fully enabled operational nodes on the net-centric information grid. Aircraft contribute
3236 observations for localized now-casts and receive them via data link as well as provide critical
3237 site-specific observations for use by nearby aircraft. UAS are used for making observations,
3238 performing weather reconnaissance missions such as scouting for favorable routes and collecting
3239 critical observations where and when needed, and collecting ionospheric data and radiation
3240 activity originating from space weather.

3241 **5.4.1 Weather Information Operations**

3242 Procedural ANSP processes, user-automated processes, and DSS use the common weather
3243 picture, including probabilities, to facilitate CDM. DSS use a risk management approach in
3244 planning CM and FCM options. The use of the common weather picture is a primary basis for
3245 CDM purposes (e.g., flow planning), but other commercially available, value-added weather
3246 sources may be used by stakeholders in making their own flight-planning decisions (e.g.,
3247 determining what preferred flight paths they will request). In developing the common weather
3248 picture, the government may choose to acquire commercially developed weather products and
3249 capabilities for inclusion in that common picture.

3250 Weather information is tailored to the operational needs of users. For example, if multiple
3251 stakeholders are looking at levels of convection for a geographic area, the locations and intensity
3252 of the convection are the same. This tailoring of weather information is enabled by maintenance
3253 of a common weather picture at different resolutions, time scales, and geographic areas (e.g., the
3254 information for an airport is presented at a higher resolution and updated more rapidly than
3255 information for adjacent oceanic locations). Pre-flight and in-flight decisions are aided by
3256 weather services that assist the user in making tailored inquiries into the common weather
3257 picture. Other weather information such as alerts, advisories, and warnings regarding significant
3258 weather changes are proactively published to stakeholders via digital communications. For
3259 example, the flight deck receives key weather updates along the route of flight, thereby
3260 enhancing dynamic decision making and flight safety.

3261 Weather Information Services include:

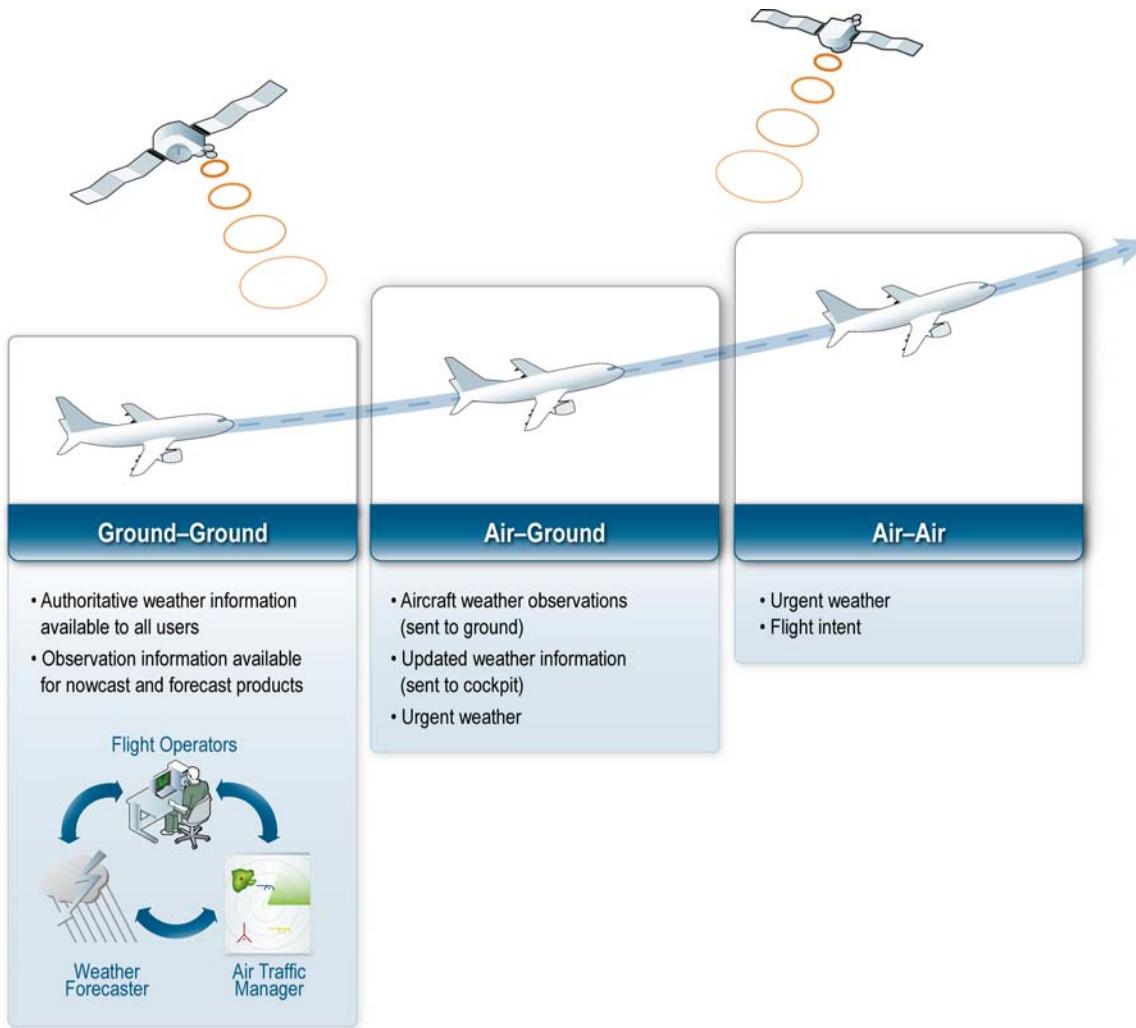
- 3262 • **Aircraft Are Capable of Receiving, Collecting, and Transmitting Weather**
3263 **Information as a Digital Data Stream.** Fully capable aircraft have the appropriate
3264 automation (communication and computing) systems to receive weather data (including
3265 hazard information) and to transmit sensor data, which will be provided to the network
3266 enabled weather. Fully capable aircraft are able to collect and integrate weather
3267 information into onboard displays and weather-mitigating operational flight programs.
- 3268 • **Hazardous Weather Is Identified in Real Time.** Network enabled weather uses ground-
3269 based, space-based, and airborne sensors and systems to provide timely, relevant,

3270 accurate, and consistent hazardous weather information to aircraft and users in near real
3271 time. Automation of traditional observations (e.g., pilot reports) facilitates improved
3272 hazardous weather identification.

- 3273 • **Observation and Forecast Are Provided for Non-Towered and Automated NextGen
3274 Towered Airports.** Network enabled weather provides current and forecast weather
3275 information from the common weather picture to non-towered and Automated NextGen
3276 Towered airports at the required spatial and temporal resolution. Hazardous weather in
3277 the terminal area that impacts departures and arrivals is forecasted and also detected in
3278 real time.
- 3279 • **Network enabled weather Provides the NextGen Decision-Oriented Tools (NDOT)
3280 with Trajectory-Based Weather.** Network enabled weather provides the NDOTs with
3281 trajectory-based weather information that is aligned with flight planning and ATM.
3282 Trajectory-based weather information (observations, forecasts, model/algorithm data, and
3283 climatology, including surface observations and weather aloft) allows full integration of
3284 weather into traffic flow decision making. Network enabled weather allows the NDOTs
3285 to identify weather-impacted airspace (both real-time or observed and forecasted) as
3286 reduced-capacity and as no-fly airspace. Network enabled weather provides the NDOTs
3287 with climatology (to permit up to at least a three-month pre-flight planning window) and
3288 provides probabilistic forecasts to allow for multiple preplanned trajectories and airspace
3289 configuration scenarios. An example of weather information operations is shown in
3290 Figure 5-3.

3291
3292

**Figure 5-3 NextGen Weather Dissemination Foundation
For Net-Enabled Weather Operations**



3293

5.4.2 Weather Information Enterprise Services

3295 An integrated, common picture of the weather facilitates dynamic decision making. Net-centric
3296 weather services, tailored to the user's needs, reduces or eliminates the requirement for
3297 stakeholders to manually gather, interpret, and integrate diverse weather data to realize a
3298 comprehensive, coherent weather picture. Weather collection and interpretation is achieved with
3299 automation assistance (with meteorological quality control) prior to dissemination. Decisions are
3300 more predictable when stakeholders use an understandable common weather picture as an
3301 informational data source.

3302 This common picture for current and forecast weather information includes attributes organized
3303 by longitude, latitude, altitude, time, and probability components (i.e., 4D plus probability).
3304 Optimal air transportation decision making mitigates the risk of conflicting courses of action by
3305 requiring a single reliable common weather picture. Weather data is collected, processed, and

distributed through a service-oriented architecture. The underlying premise is that the various weather data are consistent. Therefore, everyone looking into the weather information portal from the same aspect sees a common weather picture. However, the picture may vary on how the information is portrayed (e.g., text, audio, graphics, imagery, polygons); thus, a reliable, virtual common weather picture is provided. Furthermore, the weather source is not a single database but rather a network of information sources accessed via net-centric weather services, reinforcing the “virtual” concept. Moreover, net-centric enterprise weather services reduce stakeholder operational costs by eliminating expensive, customized, point-to-point interfaces from multiple sensors and sources. The services comprise:

- **Multiple Weather Observations and Forecasts are fused into a 4D Common Weather Picture that is distributed through Network Enabled Weather.** Weather data (observations, forecasts, model/algorithm data, and climatology) are integrated into a common weather picture (Earth’s surface to low Earth orbit is used in all weather-oriented decision processes). Weather observations are contained in network enabled weather and used by forecasting tool sets to produce forecasts (both routine and aviation impacting) for all users. Users retrieve weather information needed for decision making in real time from network enabled weather. Vendors may use information from network enabled weather to produce tailored, value-added products for use in and out of the cockpit. Some weather information, such as turbulence and icing, is also tailored to the airframe as well as the route. This capability depends on network enabled weather to disseminate a common weather picture. Weather information is also used to help evaluate environmental impacts from increased aircraft operations, such as increased noise and exhaust emissions at and near airports and in volumes of airspace that may be particularly sensitive to aircraft exhausts.
- **Weather Sensors are Included in Performance-Based Services.** Fully capable aircraft have a standardized set of weather sensors/algorithms to provide in situ wind, temperature, water vapor, turbulence, and icing data to other users directly and via network enabled weather. Aircraft may also measure non-weather parameters (e.g., volcanic ash), use forward- or downward-looking remote weather sensors, and carry dosimeters to measure the radiation environment that is affected by space weather activity.
- **UAS are used for Weather Reconnaissance.** En route weather reconnaissance UAS are equipped to collect and report in-flight weather data. Specialized weather reconnaissance UAS are used to scout potential flight routes and trajectories to identify available “weather-favorable” airspace. UAS may also carry instrumentation to measure the radiation environment that is affected by space weather activity.



6 Layered, Adaptive Security Services

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3343

3344
3345

6.1 INTRODUCTION

3346 This chapter provides an overview of the Layered, Adaptive Security Services; for a detailed
3347 look at specific aspects of this system, see the Layered, Adaptive Security Services Annex
3348 (http://www.jpdo.gov/library/NextGen_Security_Annex_v2.0.pdf). The security system does
3349 not unduly limit mobility or make unwarranted intrusions on the civil liberties of users and
3350 employees by embedding layered, adaptive security measures throughout the air transportation
3351 system, from reservation to destination. The security services framework consists of an
3352 overarching IRM system, providing informed decision making and adaptive risk mitigation
3353 strategy for securing people, airports, checked baggage, cargo and mail, airspace, and aircraft.
3354 Strong interrelationships exist with SSA, airports, ATM, safety, aircraft, and global
3355 harmonization capabilities. The Security Services concept addresses:

- 3356 • IRM
- 3357 • Secure people
- 3358 • Secure airports
- 3359 • Secure checked baggage
- 3360 • Secure cargo/mail
- 3361 • Secure airspace
- 3362 • Secure aircraft

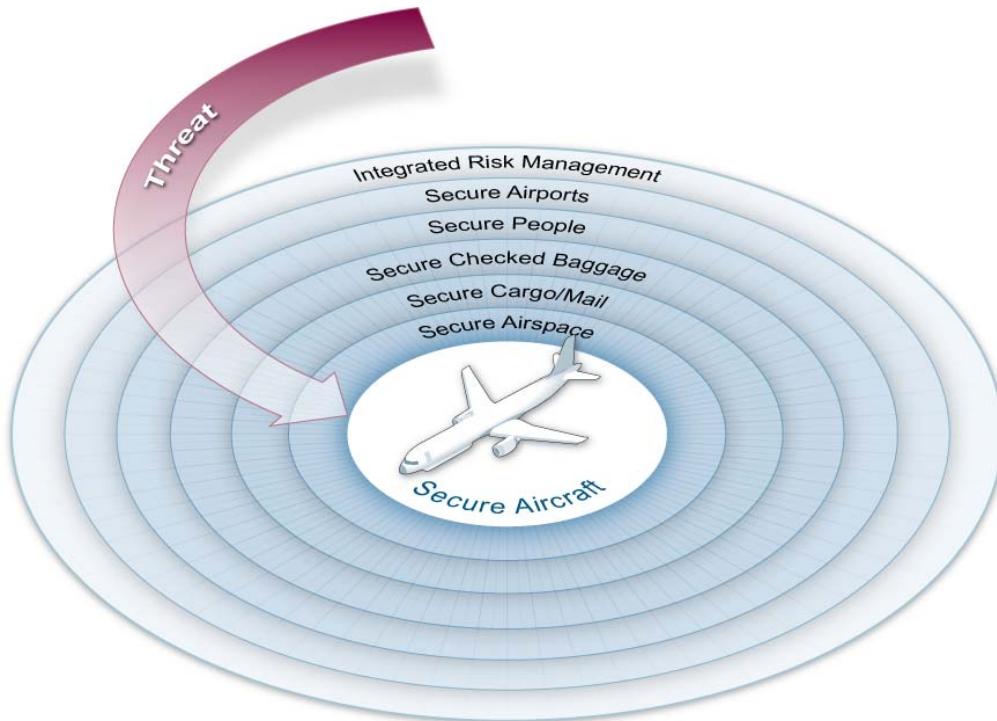
3363 Layered, adaptive security is a risk-managed security system that depends on multiple
3364 technologies, policies, or procedures that are adaptively scaled to defeat a given threat or threat
3365 category. This adaptability further permits the use of increased variability in security system
3366 operations that creates more uncertainty for an adversary. Adversaries cannot defeat one
3367 particular security measure and thereby achieve a “break-through” to operate freely with no
3368 further barriers to their activities. Furthermore, the security system has the adaptability to scale
3369 its resources, systems, and procedures to the risk level of a threat in a given situation, rather than
3370 being bound to an inflexible, “one size fits all” approach.

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Figure 6-1 Net-Centric Operations with Shared Situational Awareness

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Given the limited resources of both the government and private industry, it is critical that mitigation measures are developed based on threat and vulnerability as well as the potential consequences to individuals, critical national assets, significant events/activities, and the economy.

To achieve the requisite adaptability while maintaining effective security standards, the security system must have a sound method of prioritizing risks and assessing the proportional effectiveness of different ways of countering them. The Secure IRM process performs this essential function, directing the deployment of equipment, personnel, and procedures/policies to defeat the evolving threat. The remaining capabilities described at a high level in this chapter are the result of IRM assessments.

6.1.1 NextGen Security Management and Collaborative Framework

Security management is a shared mission among many stakeholders. The security system is optimally integrated with other NAS functions, and, through advanced networking functionality, linked to external aviation industry stakeholders and non-federal government entities. To maintain effective security management across major stakeholders, a collaborative framework is composed of the following key functions and processes:

- **National Aviation Security Policy** - embraces a broad view of threats, including direct attack, exploitation, and transfer; recognizes interdependencies and uncertainty; nurtures

3397 virtual or extended enterprises supported by connectivity of diverse, informed
3398 stakeholder partnerships. This policy also employs layered security through physical,
3399 process, and institutional layers; accounts for systemic vulnerabilities that are created by
3400 the networked nature of the aviation system; and creates an environment that facilitates a
3401 rapid, seamless return to normal business operations subsequent to an incident. This
3402 policy achieves integration with the overarching Homeland Security Presidential
3403 Directives and their subsidiary documents.

- 3404 • **Aviation Security Stakeholder Involvement** - fosters industry, federal, and local
3405 partnerships with clearly defined roles and responsibilities for prevention, protection,
3406 response and mitigation, and recovery operations at strategic, operational, and tactical
3407 levels. CDM contributes to a positive security culture. Timely, effective, and informed
3408 decision making is achieved through advanced communications and information sharing
3409 systems.
- 3410 • **Aviation Security IRM** - includes prognostic tools, models, and simulations at the
3411 strategic, operational, and tactical levels to support all stakeholder decision-makers and
3412 managers. This incorporates cost-effective best practices into the design, acquisition,
3413 deployment, and operation of aviation security system assets and infrastructures.
3414 Knowledge bases concerning threats, vulnerabilities, and practices are tailored to user
3415 profiles that proactively determine need/authorization to know.
- 3416 • **Aviation Security Implementation** - encompass a robust set of strategic, tactical, and
3417 operational capabilities and services focused on prevention, protection, response and
3418 mitigation, and recovery initiatives that are undertaken by a variety of stakeholder
3419 organizations.
- 3420 • **Aviation Security Assurance** - includes a variety of certification programs, surveillance
3421 and evaluation activities, enforcement inspections, and incident investigations performed
3422 and administered by a variety of federal, industry, and local stakeholders.

3423 The security capability describes the transformations expected to occur in the areas of checkpoint
3424 operations responsibilities, credentialing/authentication, baggage screening technology,
3425 passenger screening, Chemical, Biological, Radiological, Nuclear, and high yield Explosive
3426 (CBRNE) detection, and security system deploy-ability.

3427 Security is supported by an IRM system, monitoring, assessing, and coordinating a variety of
3428 data and communications associated with flight objects and the users. IRM describes the security
3429 methodologies and practices designed to protect and secure people, airports, checked baggage,
3430 cargo and mail, airspace, and aircraft in the NAS. The transformed system will focus on the users
3431 (passengers, workers, and crew) by incorporating deployable systems to provide RTSS;
3432 passenger and aviation worker pre-screening and state-of-the-art checkpoint systems to detect the
3433 threat; as well as cargo, baggage, and mail screening. In addition, the security system will focus
3434 on reducing threats from terrestrial weapons (lasers, man-portable air defense shoulder-fired
3435 missiles or projectile weapons) and Electromagnetic Pulse (EMP) weapons to the airframe
3436 through hardening and threat detection technology. Security management will address threats to
3437 airports, commercial spaceports, manned and unmanned aircraft systems, capturing risk to
3438 facilities and aircraft as a potential target or a weapon. With the aid of IRM, the system will

3439 allow for dynamic monitoring and management of Security Restricted Airspace (SRA) and SAA
3440 to allow for efficient and safe transit of vetted aircraft and to prevent the use of aircraft as a
3441 weapon against persons, critical national infrastructure, and significant events.



Air Transportation Security - provides layered, adaptive security, based on IRM that yields the ability to identify, prioritize, and assess risks and effectively allocates resources in support of national defense and homeland security to facilitate the defeat of an evolving threat critical to the NAS infrastructure or key resources.

3448 6.2 INTEGRATED RISK MANAGEMENT (IRM)

3449 Risk management is the ongoing process of understanding the threats, consequences, and
3450 vulnerabilities that can be exploited by an adversary to determine which actions can provide the
3451 greatest total risk reduction for the least impact on limited resources. It is inherent to every
3452 element of Layered, Adaptive Security Services, and it is conducted from the strategic to the
3453 tactical levels. IRM is an overall federated risk assessment and risk mitigation framework that
3454 guides multiple security service enterprises to assist in making decisions, allocating resources,
3455 and taking actions under conditions of uncertainty. This framework is a planning methodology
3456 that outlines the process for satisfying or exceeding security goals through prevention,
3457 protection, response and mitigation, and recovery. It satisfies the following needs:

- 3458 • To understand the spectrum of threats that could be mounted against the NAS
- 3459 • To identify the vulnerabilities that can be exploited by an adversary
- 3460 • To evaluate and prioritize assets/activities to be protected from attack
- 3461 • To determine which protective actions can provide the greatest total risk reduction for the
3462 least impact on limited resources
- 3463 • To provide the most focused and adaptive security measures to reduce the impact of
3464 security systems and procedures on air transportation

3465 IRM is characterized by a specific and consistent terminology to describe its various aspects.
3466 Threats are the likelihood of an attack on a particular asset. Vulnerabilities are weaknesses in the
3467 design, implementation, or operation of an asset or system that can be exploited by an adversary
3468 or disrupted by a natural disaster. Consequences are the result of an attack on infrastructure
3469 assets reflecting level, duration, and nature. Risks are measures of potential harm that encompass
3470 threat, vulnerability, and consequence.

3471 The assessment of risks provides a prioritized list of vulnerabilities and potential mitigation
3472 strategies. Because the adversary has the freedom to choose targets and modes of attack, the
3473 security system must develop (but not necessarily universally deploy) operationally feasible
3474 mitigations to as many potential threats as possible. Due to limited resources, mitigation

3475 requiring substantial investment (e.g., system cost or infrastructure intensive) is applied
3476 (deployed) in the order of risk level. For example, external attacks on aircraft may be an issue at
3477 some airports requiring mitigation. This does not mean that all GA airports will have or need
3478 such systems.

3479 It is also possible to apply resources effectively through technical advances in sensor design and
3480 fusion as well as cost efficiencies typical of information processing system upgrades. With the
3481 development of low-cost CBRNE sensors for low-volume operations, it will be possible to
3482 conduct screening at many more airports for commercial service. This does not mean that all
3483 non-commercial operations need to screen passengers or cargo for flights posing below-threshold
3484 risk levels. Many flights occur far from major metropolitan areas or national security restricted
3485 areas; however, flights to sensitive areas must make adjustments to mitigate their risk profile.

3486 Security system responses and procedures are applied based on the risk profile of each flight and
3487 airport facility. Facilities or flight objects that do not adopt particular security processes may still
3488 operate in the NAS, but may have to observe some restrictions depending on the given risk
3489 profile created. Yet their overall future access and performance, even with some (self-imposed)
3490 security restrictions, is considerably greater than their current access.

3491 **6.3 SECURITY SERVICES**

3492 **6.3.1 Secure People**

3493 The perception of a secure aviation system environment via publicly visible or implicit
3494 checkpoint and carry-on baggage screening operations is an extremely important tenet of the
3495 security architecture. Other less-visible security procedures may work toward similar ends and
3496 achieve them as effectively; however, the visible aspect of checkpoints and baggage screening is
3497 still the most tangible element to the general public and hence the most relied upon procedure in
3498 establishing the public's level of confidence and thereby their use of the system. The checkpoint
3499 displays an operating profile of consistency and routine, while behind the scenes it has several
3500 new screening techniques and tools that are being utilized based upon the assessed risk and, in
3501 some cases, performed randomly.

3502 Secure People puts greater reliance on an integrated screening approach to correlate
3503 credentialing and identification processes. Aviation security risks are mitigated by identifying
3504 individuals who, whether travelers or aviation personnel, are a potential threat and preventing
3505 them from gaining access to the air transportation system through pre-screening/credentialing,
3506 screening, and intervention. For travelers, aviation security is provided continuously from the
3507 time the reservation is made until the safe arrival of the flight at the destination airport and the
3508 uneventful retrieval of baggage by the passenger. For Persons With Disabilities (PWD), the
3509 Secure People capability ensures accommodation and privacy by including special training and
3510 procedures for screeners, separate screening areas, and appropriate equipment to address PWD
3511 needs. For aviation workers, a standardized credentialing process is used which includes
3512 standardized, periodic updating and re-credentialing of secure access personnel, and
3513 identification technologies to deny unauthorized individuals access to restricted areas of airports.
3514 NCO permits more valid and faster credential verification. A balance between security and

3515 customer service is maintained, permitting the consistent, efficient, and seamless movement of
3516 passengers at the airport.

3517 **6.3.2 Secure Airports**

3518 Secure Airports have an integrated facility security system scalable to differing capacity, access,
3519 and risk environments. Additionally, it includes both technological and procedural measures to
3520 protect against the dynamically evolving threat. This flexible security system leverages advanced
3521 net-centric capabilities to minimize redundant credentialing and access controls while providing
3522 SSA when security incidents occur or credentialing concerns surface.

3523 Airport net-centricity seamlessly links sensors and data sources from access and screening
3524 checkpoints for passengers, visitors, employees and vehicles, perimeters, and critical facility
3525 infrastructure. The airport security technologies and adjustable procedures are nominally
3526 transparent to passengers and cargo, and hard to predict by those who intend harm. Additionally,
3527 airports have resident response and recovery programs enabled through local and regional
3528 memoranda of agreement and supported by the federal government. In this connection, NCO
3529 maintains real-time connectivity to other regional airport operators, law enforcement, and
3530 government intelligence and SSP operational entities. These Secure Airports Services, used with
3531 IRM tools, enable quick ramp-up response operations to incidents of national significance,
3532 including CBRNE attacks on the airport or within the region. The emergency response has been
3533 appropriately rehearsed to ensure that the responders are fully prepared and informed for any
3534 contingency.

3535 The layered and overlapping security systems are in place at the following types of airport
3536 facilities:

- 3537 • Commercial (passenger/cargo) airports
- 3538 • RTSS facilities
- 3539 • Public GA airports
- 3540 • Commercial spaceports

3541 The systems also are located at the following areas within the above listed facilities, as
3542 appropriate:

- 3543 • **Airside.** Security Identification Display Area/Airport (SIDA) operations area, terminal
3544 perimeter, terminal airspace (security)
- 3545 • **Landside.** Terminal public and commercial roadways and parking lots, terminal entry
3546 and departure, airline ticketing kiosk/counter, sterile area, international arrivals/customs,
3547 security control center, response and recovery operations

3548 6.3.3 Secure Checked Baggage

3549 Secure Checked Baggage includes printing bag tags at remote locations for airport check-in.
3550 Additionally, it includes provisions for RTSS to allow passengers to undergo full screenings at
3551 off-airport locations and then be transported directly to the sterile area of the airport terminal
3552 while their screened, checked bags are taken directly to the aircraft. The screened baggage is
3553 available for direct transfer to other modes of transportation (e.g., rail, ship or bus) without
3554 further screening. Additionally, integrated trip tracking, with access by authorized third-party
3555 organizations, provides custom services such as remote check-in and baggage transport and
3556 processing capabilities.

3557 6.3.4 Secure Cargo/Mail

3558 Secure Cargo/Mail represents a critical vulnerability that was historically addressed with
3559 background investigations, inspections, and paper trails required of shippers, both known and
3560 unknown. The vision for cargo security includes freight vulnerability assessments (through the
3561 IRM process), identifying the risk level of cargo, use of sterile cargo packing areas, cargo transit
3562 safety and integrity, and CBRNE screening for air cargo.

3563 Secure Cargo/Mail prevents checked cargo/mail from endangering aircraft, aviation facilities, or
3564 people and to prevent the air cargo system from being used as a threat vector. These objectives
3565 are met through a combination of policy, procedures, information, and technology to
3566 differentiate normal commerce from threats accurately. Cargo/mail screening equipment and
3567 container sensors, with multi-sensor capabilities, are linked through secured net-centric systems
3568 to the SSP airport security operations center and other analysis centers.

3569 The security of cargo and mail begins at the point of initial packing with the manufacturer,
3570 freight consolidator, air carrier, or licensed U.S. Customs broker, (or when initial screening
3571 occurs prior to entry into the security system). The SSP integrates all information related to the
3572 flight, cargo, and aircrew to provide additional information and ensure security during transit,
3573 enabled through NCO. The SSP includes the following concepts:

- 3574 • Vetting for Secure Supply Chain Entity (SSCE)
- 3575 • Vetting for Certified Supply Chain Entity (CSCE)
- 3576 • Security screening
- 3577 • Loading and storage security
- 3578 • Surface transportation security/tracking
- 3579 • Cradle-to-grave tracking/integrity

3580 Many organizations and personnel are involved in the transport of any given piece of cargo/mail:
3581 a source or shipper, freight forwarders, indirect air carriers, and other commercial and
3582 government personnel. Because of the many prospective transfer points, cargo/mail security has
3583 to take into account the entire custody chain. Continuous risk and threat assessments must be
3584 conducted to identify risks to the supply chain, and apply measures, procedures, and policies to

reduce those risks to an acceptable level. Cargo must be initially packed in a sterile area and conveyed through a secure chain of custody to the aircraft. If any deviance from this process occurs, all cargo intended for air transport, whether on passenger flights or all-cargo operations, must undergo CBRNE screening from either the SSP or a CSCE. After CBRNE screening, the integrity of the goods shipped must be maintained until the cargo exits the air transportation system. SSCE and CSCE are regularly inspected for compliance. All personnel with access to shipped goods must be properly credentialed, authenticated, and trained to ensure a secure shipping environment. In addition, all cargo items are subject to random inspection and CBRNE screening to maintain necessary variability and verification of the supply chain.

6.3.5 Secure Airspace

Secure Airspace prevents or counters external attacks on or the use of an aircraft as a weapon against assets and people on the ground. To reduce the security risk within the air domain, Secure Airspace systems and procedures detect and prevent or mitigate:

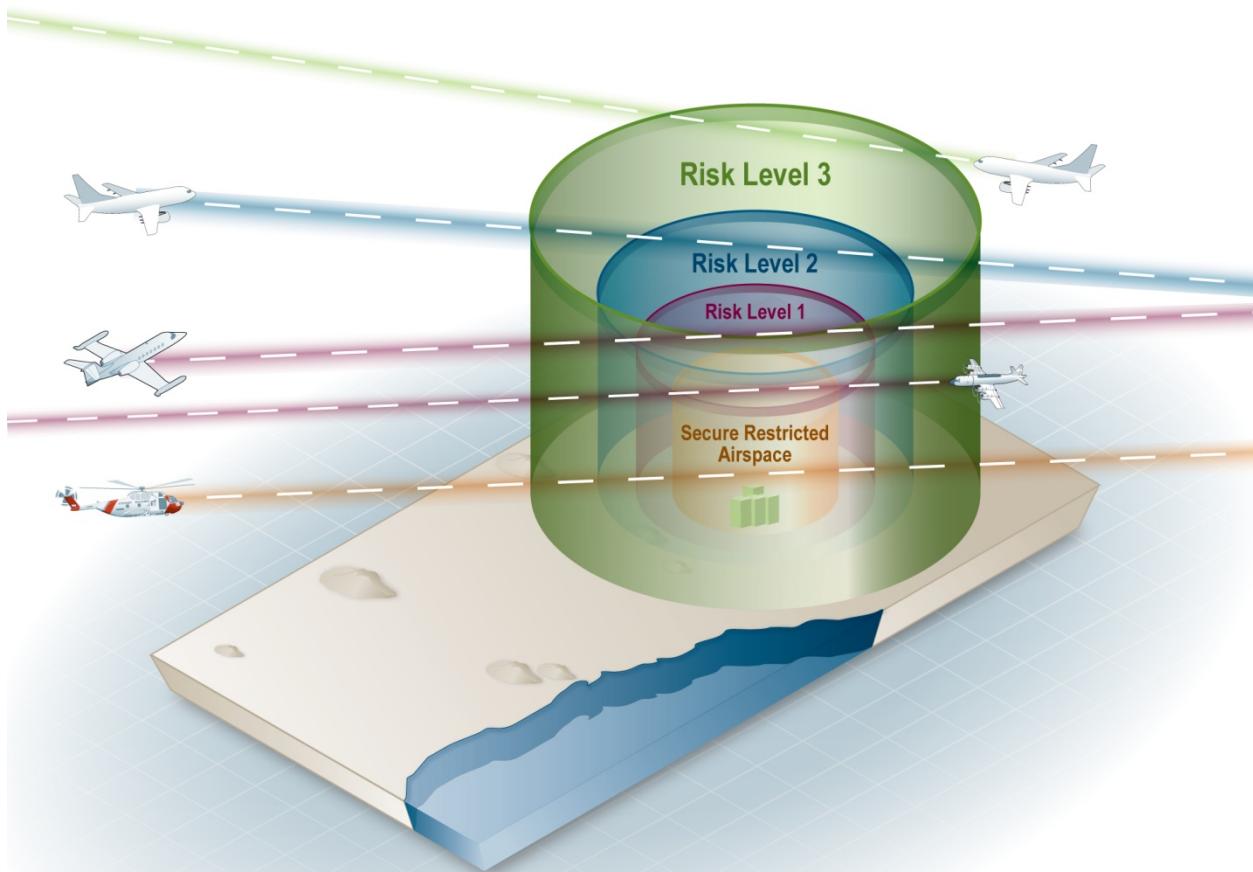
- Anomalies in aircraft operation that indicate unauthorized use or attempted unauthorized use
- Aircraft not providing the appropriate cooperative data concerning identity and intentions
- External attacks on aircraft
- Aircraft that can pose any other threat.

The risk management requirements include the following: (1) defining (almost always dynamically) the boundaries and access criteria of SRAs to protect people/assets, critical infrastructure and significant events, (2) clarifying the cooperative respective roles and responsibilities between the defense security provider, SSP, and ANSP in the event of security incidents in flight or by airborne threat aircraft, and (3) determining the risk profiles of flights.

Based on a flight object's risk profile, SRAs may initiate TFRs to isolate a potential threat. Secure Airspace modifies flight access and implements procedures based on a verification that dynamically adjusts for aircraft performance and security considerations. For instance, low-performing aircraft may have greater NAS access than high-performance, due to interception times being greater. Additionally, Secure Airspace also has Airspace Violation Detection, Alerting, and Monitoring capabilities.

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Figure 6-2 Secure Airspace - Security Restricted Airspace



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3616 **6.3.6 Secure Aircraft**

3617 The Secure Aircraft Service increases the safety and security of aircraft through a variety of
3618 hardware, software, personnel, and procedural methods. Threats that require mitigation include,
3619 but may not be limited to, hijacking/unauthorized diversion; internal explosive destruction;
3620 external attack; onboard CBRNE or other attack of crew, passengers, or aircraft systems; aircraft
3621 use as a transport for CBRNE; or aircraft use as a Weapon of Mass Destruction (WMD). The
3622 Secure Aircraft Service applies to both civilian passenger aircraft and civilian cargo aircraft.
3623 Certain types of UAS (surveillance or cargo) are included as well for threats related to
3624 unauthorized diversion, internal explosive destruction, and use as a transport for CBRNE.



7 Environmental Management Framework

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7.1 INTRODUCTION

3629 Understanding and effectively addressing environmental challenges is critical to NextGen
3630 success. Anticipated increased capacity will result in greater environmental impact and new
3631 challenges to address. There will be significant constraints to increasing NAS capacity unless the
3632 environmental impacts in the areas of noise, emissions, water quality, and greenhouse gas
3633 emissions are managed and mitigated.

3634 To be successful, airports will need to increase their efforts to address the environmental
3635 concerns of neighboring communities. Noise will continue to be a primary area of concern;
3636 however, air quality, water quality, and other environmental demands are a growing challenge to
3637 significant capacity expansion without a detrimental impact to the environment. An additional
3638 environmental challenge is to manage aviation's environmental impacts in a manner that limits
3639 or reduces their impact and enables the U.S. air transportation system to meet the nation's future
3640 transportation needs.

3641 NextGen's solution to managing mission-critical environmental resources/impacts is through the
3642 development of an Environmental Management Framework (EMF) that is fully integrated into
3643 all operations. This framework ensures *environmental protection that allows sustained aviation*
3644 *growth*. The EMF is structured to address the management of environmental resources using five
3645 functional groups focused on policy, operations, technology, tools and science, and metrics. The
3646 EMF must account for interdependencies among many environmental issues so that in
3647 addressing some, others are not exacerbated. While at the same time, the EMF must maintain a
3648 balance between environmental goals and the need to advance aviation safety, national security,
3649 and economic well-being. The goals of EMF include:

- 3650 • Reduce significant community noise and air quality emissions impacts in absolute terms
- 3651 • Limit or reduce the impact of aviation greenhouse gas emission on global climate,
3652 including the rate of fuel burn
- 3653 • Improve energy efficiency of air traffic operations
- 3654 • Support alternative fuels development
- 3655 • Proactively address other environmental concerns

3656 EMF promotes the development of a national EMS approach. EMS includes a management
3657 process to help users systematically identify, manage, monitor, and adapt to the environmental
3658 demands associated with the high volume and dynamic nature of the air transportation system.
3659 The national EMS approach is intended to facilitate an effective and common process that is
3660 adopted by all applicable U.S. aviation organizations. EMS provides a mechanism for

3661 integrating environmental protection objectives into the core business and operational decision
3662 making. While EMF provides the overarching strategy needed to achieve environmentally
3663 sustainable aviation growth, EMS delivers a management process for achieving environmental
3664 protection in user actions.

3665 The “Improved Environmental Performance” capability will use the EMS to provide enhanced
3666 environmental responsiveness in the areas of aviation airspace operations, airport planning and
3667 operations, and transformed aircraft design and technologies. These capabilities enable the
3668 fundamental operations and transform the national airspace operation.



Improved Environmental Performance - provides the ability to proactively identify, prevent, and address environmental impacts in the air transportation system. This is accomplished, through a CDM process, improved tools, technologies, operational policies, procedures, and practices that are consistent and compatible with national and international environmental regulations.

3675 **7.2 IMPROVED ENVIRONMENTAL PERFORMANCE OF SYSTEM COMPONENTS**

3676 **7.2.1 Environmental Operations**

3677 EMF is the overarching environmental architecture (including systems, business processes, and
3678 infrastructure). Changes in the air transportation system can result from increased traffic volume.
3679 These changes are compounded by greater stakeholder and community awareness of
3680 environmental issues and increasing community expectations for environmental impact
3681 reductions.

3682 **7.2.1.1 Aviation System EMSs**

3683 EMF does not treat the aviation system as a single unit, but as a community of organizations with
3684 a diverse range of requirements and drivers. The framework establishes systematic but flexible
3685 approaches that enable individual EMS programs to respond to the aviation system’s dynamic
3686 capacity demands. These approaches are supported by enhanced information flow and better
3687 connections between individual component organizations.

3688 The EMF aims to provide individual air transportation component organizations (e.g., airports,
3689 agencies, ANSP, FAA, air carriers, and manufacturers) with a flexible system to identify and
3690 manage the environmental resources that are necessary to meet their individual long-term
3691 capacity demands. This includes integrating sound EMS principles into all aviation system
3692 components and ensuring that these EMS approaches, or models, include all environmental
3693 issues but focus specifically on capacity-related environmental issues. EMS models establish
3694 standardized, systematic approaches for managing the environmental aspects of operations in
3695 support of the organization’s overarching mission. The use of focused EMS models ensures that
3696 all aviation system component organizations contain processes that help them align with critical
3697 NextGen goals.

3698 Implementing EMS models will provide mechanisms for identifying and managing issues critical
3699 to sustainable growth, transferring information, standardizing operations based on best practices,
3700 and encouraging environmental stewardship. The
3701 implementation also provides a vehicle for
3702 NextGen-level objectives to be incorporated by
3703 individual organizations as part of their EMSs,
3704 thereby aligning them with NextGen goals.
3705 Individual organizations connect through an
3706 information management system, which enables
3707 environmental information management,
3708 including tracking environmental metrics,
3709 storing best practices (e.g., on construction,
3710 maintenance, and operational procedures), and
3711 communicating environmental objectives,
3712 policies, incentives, and regulations.

3713 **7.2.1.2 Airspace Operations**

3714 The airspace operations plan seeks to create a
3715 dynamic and flexible airspace capable of
3716 supporting 2025 demand in an environmentally sustainable manner. An agile air traffic system
3717 based on advanced cockpit avionics, satellite navigation, advanced weather forecasting, and
3718 dynamic airspace has enhanced ability and flexibility to reduce emissions by maximizing
3719 routings for fuel efficiency. Environmental performance of the system is embedded in the overall
3720 performance of the air traffic system and supported by EMS goals, including the availability of
3721 up-to-date critical system information.

3722 Consistent with EMS principles, a holistic but flexible approach is used to manage key
3723 environmental issues as they pertain to specific geographic regions and to the system as a whole.
3724 This approach accounts for variations at an individual component level (e.g., airports or air
3725 carriers); EMS models implemented by individual components account for specific needs while
3726 also contributing to system-level requirements.

3727 Environmental impacts and potential constraints of terminal airspace currently are better
3728 understood than those associated with en route airspace, but there is significant uncertainty
3729 associated with 2025 projections. Therefore, the primary capability of the EMF is its ability to
3730 adapt to the complex nature of the air traffic system. For example, new technology, in concert
3731 with airspace redesign, enables optimized route selection during landing and takeoff procedures
3732 that are based on minimizing the impact of noise and emissions, minimizing costs and fuel burn,
3733 and maximizing route efficiency and safety. The establishment of environmentally friendly
3734 operational procedures (e.g., operations program directives) for all traffic conditions is one
3735 example.

3736 In terminal airspace, single-purpose procedures are replaced by more sophisticated procedures
3737 that maximize benefits based on integrated assessment and management of multiple factors,
3738 including noise, emissions, fuel burn, land use, operational efficiency, and cost. Procedures are
3739 dynamic and adapt to changing needs rather than remaining static. There are additional

What are Environmental Management Systems?

EMS is an organizational business process that consists of four phases. In the “planning” phase of an EMS, the organization identifies environmental issues with the potential to constrain future capacity. These are the focus of tactical, measurable objectives for which improvement initiatives can be undertaken during the “implementation” phase. During the “assessment” phase, the effectiveness of these initiatives is monitored and key performance metrics are tracked. Monitoring data is then used to support planning at the organization itself in the “review and adaptation” phase. In the NextGen EMS, monitoring data is also reported at an enterprise level to support NextGen-wide planning.

3740 procedures available using advanced technologies from which to select the best operational and
3741 environmental benefits.

3742 In the case of the en route environmental impacts, ongoing discussions and analyses have
3743 resolved major questions, and outcomes are integrated into the EMF. Focus is placed on
3744 understanding and identifying the direct attributable role of aircraft emissions in climate change
3745 through targeted research with national and international partners.

3746 ***7.2.1.3 Transformed Airport Planning and Operations***

3747 The greatest interaction between the NAS, communities, and environmental resources occurs at
3748 airports. By 2025, significant aircraft noise is expected to be confined within the airport
3749 boundary and over small areas of adjacent compatible land. During this time frame, airports will
3750 become emissions-friendly with ongoing transition to low- or no-emissions stationary facilities
3751 and GSE. Airport and community planning complement and support each other, and airports are
3752 valued community assets as air transportation gateways and economic engines. Through the
3753 integration of EMSs, environmental planning and mitigation is continuous and includes activities
3754 to meet long-term goals for sustainable growth in airport capacity. These activities are supported
3755 by improved information management that, for example, transfers and stores information on
3756 environmentally preferable airport practices. In addition, an advanced capability to integrate and
3757 balance noise, emissions, fuel burn, land use, energy efficiency, and the costs and effects of
3758 alternative measures will allow the selection of optimum operational modes, mitigation
3759 strategies, and surface planning procedures.

3760 The implementation of EMS will provide a flexible systematic approach to identify and manage
3761 environmental aspects of operations to meet capacity needs and environmental goals. The EMS
3762 approach is adaptable to the airport's characteristics, such as its size (large or small), its
3763 ownership (public or private), and its geography. Such a model allows airports to assess and
3764 improve environmental performance on an ongoing basis that is linked to airport development,
3765 and it facilitates both capacity growth and environmental protection. The noise, air quality, and
3766 water quality concerns identified by airports and communities as critical to sustainable growth
3767 are fully integrated into management plans that have the ability for mid-course adjustment based
3768 on continuous feedback. Therefore, airports are able to assess their specific environmental
3769 requirements for sustainable growth and develop or select approaches (based on industry best
3770 practices) to address specific operational, geographic, and local community impacts that fit
3771 within that national framework.

3772 Local environmental monitoring allows the effects of management strategies to be assessed and
3773 best practices or lessons learned to be available in real time. Monitoring enables regional and
3774 national trend analysis and supports decision making and planning. Improved environmental
3775 information availability and subsequent information sharing ensures that proven practices are
3776 widely used and successes quickly proliferated.

3777 ***7.2.1.4 Aircraft Design and Technology***

3778 Environmental considerations are a critical component of aircraft design and operations. These
3779 improvements aim to reduce costs to aircraft operators, airports, and the ANSP. Environmental

3780 regulations increasingly constrain capacity; public/private sector partnerships deliver more
3781 robust R&D that enables technological breakthroughs to reduce significant impacts. Scalable
3782 models and analytical capabilities that integrate noise, emissions, fuel burn, costs, and other
3783 factors enable development of optimized aircraft performance characteristics, based on informed
3784 decisions of any necessary tradeoffs (e.g., between noise and emissions).

3785 Alternative fuels will be available as costs, energy supply, security concerns, and environmental
3786 factors drive their development for aircraft. Additionally, the use of environmentally sensitive
3787 technology will facilitate a prompt and efficient development process where innovation, such as
3788 environmentally friendly airframe and engine design, is encouraged. Design, product
3789 development, testing, and certification steps are well established, with changes in policy enabling
3790 a more direct flow from their conception to implementation. This, combined with increased
3791 demand from aircraft operators, provides for a strong market for environmentally sensitive
3792 aviation technology.

3793 **7.2.2 Environmental Management Framework Policies and Capabilities**

3794 EMF is a single, fully integrated, interconnected system. This framework is used to manage and
3795 mitigate environmental impacts that constrain capacity in the NAS. An integrated EMF,
3796 consistent with this ConOps, is based on researching, designing, and implementing a broad set of
3797 enabling services and capabilities (i.e., systems and infrastructure).

3798 **7.2.2.1 Policy**

3799 **NextGen Environmental Policy.** Development of a unified environmental policy supported by
3800 a wide array of air transportation system stakeholders (e.g., airports, aircraft operators, agencies,
3801 and communities) assist component organizations with aligning their environmental systems
3802 with long-term goals and objectives. The establishment of long-term, measurable targets that
3803 address environmental issues (e.g., noise, emissions, fuel, climate effects, and water quality) is
3804 central to this policy. While this policy provides an overarching framework, it also allows
3805 sufficient flexibility to ensure that organizations can design their programs to meet their unique
3806 challenges. Performance metrics provide a yardstick for monitoring and assessing progress
3807 toward meeting environmental targets. Metrics will be appropriate for use by the various air
3808 transportation system component organizations. These are reported via a net-centric
3809 environmental information management system for the purposes of analysis, continuous
3810 improvement, and public dissemination.

3811

3812

Figure 7-1 Environmental Management Framework

3813

3814 **Standardized EMS Model.** Flexibility is critical for EMS to be applied to a diverse range of organization types; however, to meet future capacity challenges, EMS will need to include mechanisms for incorporating overarching environmental objectives (e.g., reduction of community noise), reporting with standardized metrics, and linking to an environmental information management system. The EMS model will be developed using existing best practices based on the globally recognized International Standards Organization (ISO) 14001 standards and will be sufficiently flexible to support the diverse needs of aviation system component organizations.

3822 **Incentives System.** Although the EMF is expected to bring about cost savings to the system as a whole by increasing efficiency, incentives will likely be necessary to increase implementation and encourage environmental improvements at a more rapid pace than the market would normally provide. The consideration of incentives is tied to specific environmental program initiatives or goals.

3827 **Information Management System.** A robust information management system is critical for transferring environmental information throughout the system. This system, for example, provides real-time information to aircraft operators and the ANSP on dynamically forecasted areas of noise sensitivity, areas susceptible to dispersion of pollution, and volumes of airspace

3831 that are sensitive to emissions, so that these factors can be included in planning routes,
3832 approaches, and departures. Organizations are also able to input environmental metrics data,
3833 such as emissions and noise monitoring data, from monitoring equipment directly into the
3834 system. Subsequent data analyses enable better decision making and policy development,
3835 allowing for the adjustment of environmental objectives. They also facilitate the development of
3836 effective incentives and communication of all of these actions. Therefore, this single enterprise-
3837 wide system supports all the environmental information management needs.

3838 **7.2.2.2 Operations Initiative**

3839 **Integrated Environmental Planning.** Flexible planning enables airports to make midcourse
3840 corrections to planned initiatives, thus shortening the planning horizon. Planning includes greater
3841 involvement of stakeholder groups and local communities. As part of the EMS, airports conduct
3842 standardized environmental evaluations to identify environmental resources that are adversely
3843 impacted and/or have the potential to constrain future airport capacity. This information supports
3844 long-term planning efforts and helps direct airport improvement initiatives to mitigate potential
3845 future resource constraints. Standardized environmental evaluations are reported via the
3846 information management system so that it is possible to identify the specific, local environmental
3847 issues that must be addressed to be enabled. This allows organizations to review regional and
3848 national trends and support planning and decision making.

3849 **Airport Approaches.** A range of environmentally sensitive operational procedures is developed
3850 to assist airports and aircraft operators with minimizing environmental impacts. Currently, most
3851 aircraft use the standard approach route at an airport, though large numbers of noise abatement
3852 procedures are used; however, aircraft that use quiet technology will no longer produce
3853 significant noise impacts and therefore will be able to use a wider range of approaches. These
3854 procedures, developed based on improved tools and information (e.g., enhanced real-time
3855 weather information), increase airport efficiency and ensure the maximum number of aircraft
3856 operations can be accommodated within environmental limits (e.g., state implementation plan air
3857 quality requirements, land use compatibility guidance with aircraft noise exposure, or water
3858 quality regulations), without impacting capacity.

3859 **Environmental Routes Consideration.** This initiative introduces environmental considerations
3860 into the route planning decision making process, including identifying and considering
3861 cumulative effects in routing decisions and providing preference to quieter and less-polluting
3862 aircraft. In addition, advanced navigation systems enable greater routing flexibility without
3863 impacting capacity, while also enabling en route adjustments according to on-the-ground
3864 conditions (e.g., designated quiet times or air quality emergency days). For example, aircraft that
3865 have low noise and emissions have access to a wider selection of routes than those that do not
3866 have comparable technology. Enhanced observation and forecast of weather information allows
3867 better prediction of noise and emissions impacts.

3868 **Ground Procedures.** The implementation of EMS encourages the use of a range of
3869 environmentally sensitive and cost-effective standardized procedures for ground activities. These
3870 include converting GSE to alternative and low-emission fuels (e.g., use of fixed underground
3871 services), reducing the time spent on the ground by aircraft, reducing the use of auxiliary power
3872 units, using environmentally sensitive deicing chemicals, and employing a wide range of other
3873 procedures. These standardized airport ground procedures are focused on enhancing surface

3874 operations, reducing delays, and minimizing environmental impacts. In particular, through the
3875 implementation of EMS, organizations use these activities in a focused manner, specifically
3876 targeting identified environmental impacts.

3877 **Analytical Tools.** Understanding the relationship and interdependencies between various
3878 environmental impact categories is critical. For example, if an action is taken to reduce
3879 emissions, will this affect another impact category, such as noise? A suite of transparent,
3880 integrated aviation noise and emissions models is developed to help planners understand the
3881 environmental impacts of their actions holistically. The suite of models includes:

- 3882 • The Environmental Design Space (EDS), a capability to provide integrated analysis of
3883 noise and emissions at the aircraft level
- 3884 • The Aviation Environmental Design Tool (AEDT), which provides integrated capability
3885 to generate interrelationships between noise and emissions and among emissions at the
3886 local and global levels
- 3887 • The Aviation Environmental Portfolio Management Tool, which provides the common,
3888 transparent cost/benefit methodology needed to optimize choice among standards,
3889 market-based options, policies, and operational procedures to gain the largest
3890 environmental benefit while understanding cost

3891 This suite of models allows government agencies and airport operators to understand how
3892 proposed actions and policy decisions affect noise and emissions. The models help industry
3893 understand how operational decisions influence proposed projects related to aviation noise and
3894 emissions.

3895 The tools allow optimized environmental benefits of proposed actions and investments,
3896 improved data and analyses on airport/airspace capacity projects, and increased capability to
3897 address noise and emissions interdependencies in the resolution of community concerns, health
3898 and welfare impacts, and better targeting of solutions to problems. Ultimately, they will facilitate
3899 more effective portfolio management and support the EMS process.

3900 **7.2.2.3 Technology**

3901 **Clean and Quiet Technologies.** In the near term, new technologies to improve ATM enable
3902 new, quieter, and cleaner operations. In the mid-term, technologies from NASA's Quiet Aircraft
3903 Technology (QAT) and Ultra-Efficient Engine Technology (UEET) programs will be matured
3904 for private-sector implementation. In addition, the Research Consortium for Lower Energy,
3905 Emissions, and Noise Technology (CLEEN) is a partnership developed to make the aviation
3906 technology advances needed for quieter, cleaner, and more energy efficient systems. In the long
3907 term, new engines and aircraft will feature enhanced engine cycles, components to enable quieter
3908 operations, more efficient aircraft aerodynamics, and reduced weight. These technology
3909 advancements enable significant reductions in noise and emissions.

3910 **Technology Development Processes.** Aircraft design, navigational capabilities, and technology
3911 play a central role in increasing capacity. The development of environmentally sensitive
3912 technology is encouraged by an efficient, expeditious R&D program. A critical aspect will be the

3913 development of an innovative and sustainable source of funding and the formation of
3914 public/private partnerships to facilitate the movement of technology from the conceptual phase
3915 through to its operational use. CLEEN is an example of the type of partnership needed to
3916 advance technology.

3917 **7.2.2.4 Science/Metrics**

3918 **Environmental Metrics.** Environmental performance indicators (e.g., noise and emissions),
3919 combined with other system information (e.g., forecasted traffic flows, market data, fleet size,
3920 technology implementation, and operational procedures), provide the needed information to
3921 quantify the individual environmental impacts (noise impacts, local air quality, and global
3922 climate change). Based on information from the results of such scientific assessments,
3923 environmental metrics are defined to put environmental impacts on a common scale and assign
3924 relative priority to reach a quantified goal. The metrics are used to derive analytical tools to
3925 study interdependencies and perform cost/benefit analyses. These tools in turn drive policy,
3926 regulations, incentive programs, national objectives, operational procedures, and technology
3927 design goals. The development of new metrics to assess the impact of aviation activities on
3928 environmental and health and welfare enables a robust EMS framework. Next-generation
3929 metrics, based on improved scientific knowledge and computations of interdependent
3930 relationships and related benefit/costs, provide an enhanced platform for environmental decisions
3931 and mitigation. Metrics include new operating paradigms, such as VLJs and supersonic aircraft.

3932 **7.2.3 Environmental Management Framework Support**

3933 The EMF focuses on improving linkages between various components of the air transportation
3934 system (e.g., airports, aircraft operators, federal agencies, and manufacturers) and establishing a
3935 systematic but flexible framework to meet environmental protection needs for sustainable
3936 growth. Where possible, this aims to enable decision making and planning at the implementation
3937 level with support from several mission support functions. These functions (e.g., environmental,
3938 market, social trends, best practices, lessons learned, feedback, incentives, monitoring) can
3939 provide more robust information to all components through an information management and
3940 communication system. In addition, cross-functional groups that include representatives from
3941 stakeholders review trends, policy, monitoring, and goals at a national level. These groups
3942 provide a forum for discussing research, funding, policy, regulation, tools, and other issues
3943 linking the aviation system as a whole.



8 Safety of Air Transportation Services

3945

3946 8.1 INTRODUCTION

3947 The U.S. air transportation system is the safest in the world and has been for a long time.
3948 Increasing the safety of worldwide air transportation requires the future air transportation system
3949 to control known risks, identify emerging risks, and integrate safety into system evolution.

3950 Creating the potential for significant growth in system capacity demanded by NextGen will
3951 introduce increased complexity in the air transportation system, and commensurate
3952 improvements in safety performance will be necessary. To achieve these improvements, there
3953 must be a fundamental change in the way safety is approached. Today, safety improvements are
3954 largely focused on addressing prior accidents. Safety management services will evolve from
3955 today's post-accident interventionism to predictive evaluation and management of hazards and
3956 their potential safety risks. The JPDO has created a safety management framework that is based
3957 on a National Aviation Safety Strategic Plan, which has been coordinated across industry and the
3958 NextGen government partners. The plan established the following three safety goals:

- 3959 • **Safer Practices.** Assures safety by applying consistent safety management approaches;
3960 comprehensive safety information sharing, monitoring, and analysis; and developing
3961 inherently safe practices.
- 3962 • **Safer Systems.** Aims aviation system technologies at managing hazards, eliminating
3963 recurring accidents, and mitigating accident and incident consequences.
- 3964 • **Safer Worldwide.** Harmonizes system technologies, standards, regulations, and
3965 procedures domestically and internationally to create an equivalent and improved level of
3966 safety across air transportation system boundaries.

3967 Safety goals are intended to permit increases in capacity and efficiency by ensuring that the
3968 system's safety is maintained. As concepts are designed and developed with safety embedded,
3969 they will be expected to contribute to Safer Practices, Safer Systems, and Safer Worldwide.
3970 NextGen concept implementation must mitigate known risks. It also must not introduce
3971 significant sources of new risk. Transforming the air transportation system will include
3972 technological changes and human and institutional adjustments. Safety risks associated with
3973 changing roles and responsibilities for individuals and organizations may prove quite challenging
3974 to implement safely. The "Improved Safety Operations" capability describes a safer, more
3975 efficient, higher capacity air transportation system.



3982

Improved Safety Operations - provides integrated safety management throughout the air transportation system by increased collaboration and information sharing tools, equipment, and products for stakeholders. This capability employs improved automation (e.g. DSS), technology innovations, prognostic safety risk analysis, and enhanced safety promotion and assurance techniques that are consistent and compatible with national and international regulations, standards, and procedures.

The JPDO, along with its member agencies and industry partners, will ensure safety by establishing and maintaining a National Aviation Safety Strategic Plan for the air transportation system. Key aspects of this plan include facilitating and stimulating the continuous improvement of the safety culture among stakeholders; consistently, systematically, and proactively applying and improving SRM practices, including increasing the sharing of safety-critical data; and enhancing safety assurance. The JPDO and its stakeholders will jointly define an effective SMS that leverages government and industry experience to quickly identify and address non-normal, tactical, and strategic increased risk operations.

8.1.1 National Aviation Safety Strategic Plan

A clear and cohesive National Aviation Safety Strategic Plan promotes continuous improvement in safety practices and systems safety, domestically and internationally, across air transportation system boundaries. This plan serves as the guiding principle for all government and industry participants. It sets objectives and identifies strategies within each goal area. Safer Practices seek to provide consistent safety management approaches that are implemented throughout government and industry, to provide enhanced monitoring and safety analysis of the air transportation system, and to provide enhanced methods to ensure that safety is inherent. Safer Systems seek to provide risk-reducing systems interfaces, and to provide safety enhancements for airborne and ground-based systems. Safer Worldwide encourages development and implementation of safer practices and safer systems, and seeks to establish equivalent levels of safety across air transportation system boundaries.

8.1.2 Safety Improvement Culture

A positive safety culture will focus government and industry on empowering individuals across functional lines to act upon reliable data according to clear expectations of measurement and behavior. An organization's safety culture is the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment, style and proficiency of an organization's health and safety programs. This positive pervasive culture is throughout all government and aviation industry stakeholders, which facilitates a more proactive use of SRM principles and practices. These characteristics include, but are not limited to, management accountability, non-reprisal reporting, consistent use of SRM best practices, and sharing safety data and lessons learned.

8.1.3 Safety Risk Management

SRM is a construct that takes into account the frequency of an undesired outcome along with its possible consequences, permitting a rationale for appropriate prioritization of remedial action. It is a structured approach for identifying potential breakdowns in the system's operation, understanding their impacts on safety, identifying mitigation strategies, and evaluating and monitoring the strategies' effectiveness. NextGen uses advanced data analysis, risk modeling, and simulations techniques, where applicable, for a systematic and comprehensive understanding of system and operational risk. Additionally, these techniques identify and understand the roles of precursors in past and potential accidents, and to evaluate the effectiveness of risk mitigation strategies, thus allowing accident precursors to be identified and proactively managed. Critically

4023 understanding the accident precursors and the effectiveness of risk mitigation strategies helps
4024 “... ensure safety requirements are established at the front end of every aviation process to
4025 prevent accidents before they happen.”¹³ Prognostic risk assessments based on data analysis and
4026 risk modeling techniques are used where feasible to quantify safety risk levels of system changes
4027 prior to implementation. Properly appreciating the interdependent and hierarchical risks of
4028 various operational improvements ensures optimal resource allocation for safety research and
4029 implementation.

4030 **8.1.4 Safety Information Integration**

4031 The integration and sharing of high-quality, relevant, and timely aviation safety information is
4032 critical to the operational success of the Safety Management Enterprise. The Aviation Safety
4033 Information Analysis and Sharing (ASIAS) environment is a combination of processes,
4034 governance, technologies, information protection policies and standards, and architectures used
4035 to connect Safety Management Enterprise resources, including information, organizations,
4036 services, and personnel.

4037 In 2025, the ASIAS environment will support multiple levels of stakeholders within the Safety
4038 Management Enterprise, including government and private-sector decision makers with the
4039 responsibility of maintaining the aviation record as the safest mode of transportation. To do this,
4040 ASIAS provides easy access to a suite of tools used to extract relevant knowledge from large
4041 amounts of disparate safety information.

4042 To facilitate the trusted exchange of aviation safety information, ASIAS leverages net-centric
4043 features by implementing need-to-know, role-based access capabilities. ASIAS plays a critical
4044 role in establishing and maintaining information protections. Further, ASIAS implements and
4045 continuously improves an Electronic Directory Service, a one-stop resource for stakeholders to
4046 discover relevant aviation safety information assets across multiple domains. Lastly, ASIAS
4047 establishes and continuously refines interoperability techniques by joining disparate data sources
4048 to uncover system-level hazards that were once undiscoverable.

4049 **8.1.5 Enhanced Safety Assurance**

4050 Safety Assurance is the independent oversight function that tests, evaluates, and certifies, as
4051 necessary, products and processes to ensure safety for the public and the stakeholders. The
4052 regulatory authority continuously measures and assesses the effectiveness of stakeholder SMSs
4053 through joint audits and trend analysis. As experience dictates, performance-based standards are
4054 continuously reviewed and revised. The responsibility for safety assurance is distributed among
4055 and between the regulators and the providers. As a result of this delegation, the regulatory
4056 authority is better equipped to focus resources on the most safety-critical systems and operations.
4057 To support national-level proactive hazard identification, risk assessments, and the Safety
4058 Assurance function, the “incompatible databases scattered throughout government and
4059 industry”¹⁴ are transformed into a coordinated and interlinked data source using the network-
4060 enabled infrastructure. The safety-critical events and data are reported and shared without fear of
4061 disciplinary or legal action. Mechanisms are in place for protecting competitive information.

¹³ NGATS Integrated Plan, 2004.

¹⁴ NGATS Integrated Plan, 2004.

4062 **8.2 SAFETY MANAGEMENT ENTERPRISE SERVICES AND** 4063 **CAPABILITIES**

4064 National-level SMS enable facilitation of safety management and cooperation across aviation
4065 stakeholder organizations. These services provide coordination of safety activities such as
4066 research and risk mitigation strategies, injection of critical and timely safety information and
4067 lessons learned (where appropriate), and regulatory oversight to assure the public of the safety of
4068 air transportation. The safety services may be provided to varying degrees by local or federal
4069 government agencies, or by industry associations, technical societies, or other nongovernmental
4070 organizations. They may be either permanent or temporary bodies. This does not diminish the
4071 responsibility for improving and managing safety that is the foundation for each stakeholder
4072 organization's safety culture.

4073 **8.2.1 Aviation Safety Strategic Plan Service**

4074 The Safety Strategic Plan Service provides a coordinated and maintained National Aviation
4075 Safety Strategic Plan that establishes safety goals, and identifies objectives and strategies for
4076 implementation by government and industry in support of those goals.

4077 **8.2.2 Safety Promotion Service**

4078 The Safety Promotion Service provides:

- 4079 • A Safety Culture Improvement Plan, which includes examples of strategies and tools that
4080 can be used by the stakeholders
- 4081 • Implementation guidelines for safety culture improvement
- 4082 • Capabilities for additional research into the relationship between safety climate scores
4083 and mishap rates
- 4084 • Development and distribution of material that facilitates awareness of the importance of
4085 organizational culture in fostering safety

4086 **8.2.3 Safety Risk Management Service**

4087 The SRM Service provides:

- 4088 • Safety data management capability, including data sharing and protection, and formatting
4089 requirements to facilitate data analysis and reporting
- 4090 • Integrated risk assessment via data analysis, models, and simulations development,
4091 maintenance, and applications designed as an aid to understanding the relative risks and
4092 also the effectiveness of mitigation strategies
- 4093 • Continued understanding of safety culture impacts

- 4094 • Assessments of the impact on safety (including on safety culture) of proposed new
4095 regulations

4096 **8.2.4 Safety Information Integration Service**

4097 The Safety Information Integration Service provides:

- 4098 • A centralized location for aviation safety information required to support the Safety
4099 Management Service
- 4100 • Large amounts of safety information from multiple domains under one virtual roof
- 4101 • Processes for acquiring access to data from multiple, disparate information sources
- 4102 • Authorized end users with easy and timely access to relevant aviation safety information
- 4103 • Role-based, need-to-know authorization features
- 4104 • Coordination and maintenance of aviation safety information protection policies and
4105 procedures
- 4106 • Adaptation to meet the ever-changing safety information requirements of the Safety
4107 Management Enterprise operations

4108 **8.2.5 Safety Assurance Service**

4109 The Safety Assurance Service provides:

- 4110 • Certification
 - 4111 – SMS certification
 - 4112 – System and operation certification
- 4113 • Training
- 4114 • Independent evaluations (using SRM services) of systems, operations, and safety culture
- 4115 • Accident investigation services
- 4116 • Other regulatory and oversight services
- 4117 • Integration of safety management into infrastructure planning and management, and into
4118 intermodal operations
- 4119 • Regulatory and policy enforcement service

4120 **8.3 INTEGRATION OF SMS INTO NEXTGEN SERVICES**

4121 All modifications to existing systems, procedures, equipment, and policies, and all
4122 transformations, undergo the safety risk analysis and management process. Each of the services
4123 identifies the requirements to meet safety performance requirements through integrated safety
4124 assessments and implements SMS to accomplish the goals. The NextGen-integrated SMS

4125 specifies a collaborative and integrated safety hazard/mitigation strategy. Results from safety
4126 assessments are factored into the operational data requirements for each of the services. SMS
4127 data required for identification and tracking of hazards and trend analysis is centrally managed
4128 and accessible to users. SMS best practices and lessons learned are coordinated across the
4129 services.

4130

Appendix A: Acronyms

Term	Definition
4DT	Four-Dimensional Trajectory
ACAS	Airborne Collision Avoidance System
AEDT	Aviation Environmental Design Tool
AIS	Aeronautical Information Services
ANSP	Air Navigation Service Provider
ANT	Automated NextGen Tower
AOC	Airport Operations Center
ARTCC	Air Route Traffic Control Centers
ASIAS	Aviation Safety Information Analysis and Sharing
ATC	Air Traffic Control
ATM	Air Traffic Management
BLOS	Beyond Line-of-Sight
BRAC	Base Realignment and Closure
C-ATM	Collaborative Air Traffic Management
CBP	Customs and Border Protection
CBRNE	Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive
CDM	Collaborative Decision-Making
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CLEEN	Consortium for Lower Energy, Emissions, and Noise Technology
CM	Capacity Management

Term	Definition
CNS	Communications, Navigation, and Surveillance
COI	Communities of Interest
ConOps	Concept of Operations
CSCE	Certified Supply Chain Entity
CSPA	Closely Spaced Parallel Approach
CST	Commercial Space Transportation
CTA	Controlled Time of Arrival
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
DSS	Decision Support System
DST	Decision Support Tool
DUAT	Direct User Access Terminal
EDS	Environmental Design Space
EMAS	Engineered Material Arresting System
EMP	Electromagnetic Pulse
EMS	Environmental Management System
EVO	Equivalent Visual Operations
FAA	Federal Aviation Administration
FCM	Flow Contingency Management
FIDS	Flight Informational Display Systems

Term	Definition
FIR	Flight Information Region
FL	Flight Level
FOC	Flight Operations Center
FOD	Foreign Object Debris
GA	General Aviation
GIS	Geospatial Information Services
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSE	Ground Support Equipment
IAP	Instrument Approach Procedure
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IRM	Integrated Risk Management
ISO	International Standards Organization
JPDO	Joint Planning and Development Office
LAAS	Local Area Augmentation System
MPO	Metropolitan Planning Organization
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVAID	Navigational Aid

Term	Definition
NDOT	NextGen Decision Oriented Tool
NEI	Network Enabled Infrastructure
NextGen	Next Generation Air Transportation System
NGATS	Next Generation Air Transportation System (old)
NOTAM	Notice to Airmen
NPIAS	National Plan of Integrated Airport Systems
ODNI	Office of the Director of National Intelligence
OPD	Optimized Profile Decent
OSTP	Office of Science and Technology Policy
PBN	Performance-Based Navigation
PIC	Pilot-in-Command
PIRG	Planning and Implementation Regional Group
PNT	Positioning, Navigation, and Timing
PWD	Person with Disability
QAT	Quiet Aircraft Technology
QoS	Quality of Service
R&D	Research and Development
RCP	Required Communications Performance
RFID	Radio Frequency Identification
RNAV	Area Navigation
RNP	Required Navigation Performance
RPA	Remotely Piloted Aircraft

Term	Definition
RTSS	Remote Terminal Security Screening
SAA	Special Activity Airspace
SIDA	Security Identification Display Area
SM	Separation Management
SMS	Safety Management System
SNT	Staffed NextGen Tower
SRA	Security Restricted Airspace
SRM	Safety Risk Management
SSA	Shared Situational Awareness
SSCE	Secure Supply Chain Entity
SSP	Security Service Provider
SWIM	System-wide Information Management
TBO	Trajectory-Based Operations
TCAS	Traffic Alert and Collision Avoidance System
TERP	Terminal Instrument Procedure
TFM	Traffic Flow Management
TFR	Temporary Flight Restriction
TM	Trajectory Management
TMI	Traffic Management Initiative
UAS	Unmanned Aircraft System
UEET	Ultra-Efficient Engine Technology
V/StOL	Vertical/Short Takeoff and Landing

Term	Definition
VFR	Visual Flight Rule
VLJ	Very Light Jet
VMC	Visual Meteorological Condition
WAAS	Wide Area Augmentation System
WMD	Weapon of Mass Destruction
Wx	Weather

4131

Appendix B: Glossary

Term	Definition
Aeronautical Information Service (AIS)	The near-real-time transmission of accurate aeronautical information, including updates on airspace restrictions; performance requirements for airspace access and operations; system outages; airport status information; static information, such as approach plates; and certain fixed airspace definitional data, such as fixed SAA and airport information.
Air Carrier	Operational users of NextGen that includes commercial passenger or cargo airlines, military air commands, business aviation, and private air vehicle operators.
Air Domain	The global airspace, including domestic, international, and foreign airspace, as well as all manned and unmanned aircraft operating in and people and cargo present in that airspace, and all aviation-related infrastructures.
Air Navigation Service Provider (ANSP)	The organization, personnel, and automation that provide separation assurance, traffic management, infrastructure management, meteorological & aeronautical information, navigation, surveillance services, clearances, airspace management, and aviation assistance services for airspace users.
Air Navigation Service Provider (ANSP) Flow Airspace	High-density, moderate complexity airspace where the flight operator executes a 4DT agreement. TM ensures the overall flows are well behaved so that potential conflicts are kept to a minimum. SM is performed automatically by ground automation. If conflicts are detected, the ground automation issues revised 4DTs to the flight operator.
Air Traffic Management (ATM)	The dynamic, integrated management of air traffic and airspace—safely, economically, and efficiently—through the provision of facilities and seamless services in collaboration with all parties.
Airborne Self-Separation	All aircraft within the airspace or airport movement area maintaining separation from all other aircraft within the airspace or airport movement area according to defined rules and separation criteria. The ANSP is not responsible for separation between aircraft. When authorized by the ANSP, equipped aircraft in this airspace maintain separation from all other aircraft, including those managed by the ANSP.
Airborne Separation	Refers to separation delegated to an individual aircraft to maintain separation from a designated aircraft, either in flight or on the airport movement area, such as for a crossing or passing maneuver. Separation of this aircraft from all other aircraft, including all aircraft to which separation has not been delegated, remains the responsibility of the ANSP. Pairwise separation and CSPA are also in this category. The process of spacing delegated aircraft from other aircraft (i.e., in-flight, on approach, or departure) visually, vertically, longitudinally, and/or laterally.
Airborne Separation Assurance	A capability of the aircraft to maintain awareness of and separation from other aircraft, airspace, terrain, or obstacles. There are four different levels of airborne separation assurance (based on the RTCA definition)—airborne traffic situational awareness, airborne spacing, airborne separation, and airborne self-separation.

Term	Definition
Airborne Spacing	The capability of one aircraft to achieve and maintain a defined distance in space or time from another aircraft. Separation responsibility remains with the ANSP, unless self-separation is designated.
Airborne Traffic Situational Awareness	Flight crew knowledge of nearby traffic depicted on a cockpit traffic display without any change of separation tasks or responsibility.
Aircraft	Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface. An aircraft can include a fixed-wing structure, rotorcraft, lighter-than-air vehicle, or a vehicle capable of leaving the atmosphere for space flight.
Airport	A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft. An area on land or water that is used or intended to be used for the landing and takeoff of aircraft and includes its buildings and facilities, if any.
Airspace Classification	Airspace with a common air traffic management interest and use, based on similar characteristics of traffic density, complexity, air navigation system infrastructure requirements, aircraft capabilities, or other specified considerations wherein a common detailed plan will foster the implementation of interoperable CNS/ATM systems.
Airspace Design	The process of designing routes, fixes, sectors, and other structural/operational elements of the National Airspace System (NAS) while ensuring safety, security, and efficiency.
Area Navigation (RNAV)	A method of navigation that permits aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these. Due to the different levels of performance, area navigational capabilities can satisfy different levels of required navigational performance (RNP).
Area Navigation (RNAV) Operations	Aircraft operations that provide more direct routing between the departure and arrival airports. RNAV Operations remove the requirement for a direct link between an aircraft and a navigational aid. Waypoints are developed for the aircraft to navigate by using bearing and distance information from nearby navigational aids.
Area Navigation (RNAV) Route	A specified route designed for channeling the flow of traffic as necessary for the provision of air traffic services. Note: The term "ATS route" is issued to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure, etc.
Arrival/Departure Airspace	Airspace from the top of climb or descent to the airport surface. It includes only the arrival and departure corridors in current use, but extends to en-route altitudes.
Automated NextGen Tower (ANT)	A facility where sequencing services and basic airport information are provided without the use of ANSP personnel, at a service level that is enhanced compared with typical non-towered airports.

Term	Definition
Auto-Negotiation	The interaction among two or more systems to identify a specific operational response acceptable to the parties (e.g., flight operator and ANSP) served by the automated system. The automated systems would use the known operating constraints or user preferences to identify the preferred response.
Capacity	The maximum number of aircraft that can be accommodated in a given time period by the system or one of its components (throughput).
Capacity Management	The long-term and short-term management and assignment of NAS airspace and routes to meet expected demand. This includes assigning related NAS assets as well as coordinating longer term staffing plans for airspace assignments. It includes the allocation of airspace-to-airspace classifications based on demand, as well as the allocation of airspace and routes to ANSP personnel to manage workload.
Collaborative Air Traffic Management	The collaborative process among the ANSP, flight operators, airport operators, and other stakeholders, to manage objectives for capacity management, flow contingency management, and TM. Collaborative air traffic management (C-ATM) is the means by which flight operator objectives and constraints are balanced with overall NAS performance objectives.
Complexity	A description of traffic demand levels that factors large numbers of vertically transitioning aircraft, aircraft crossing paths, and aircraft speed variations.
Conflict	Any situation involving an aircraft and a hazard in which the applicable separation minima may be compromised.
Constraint	Any limitation on the implementation of an operational improvement, or a limitation on reaching the desired level of service.
Controlled Time of Arrival (CTA)	The assignment and acceptance of an entry/use time for a specific NAS resource. Examples include point-in-space metering, time to be at a runway, or taxi waypoints.
Cooperative Surveillance	The determination of an aircraft's position utilizing equipment on the airframe. In comparison, non-cooperative surveillance would be the determination of an aircraft's position without the aircraft participating.
Demand	The number of aircraft requesting to use the ATM system in a given time period.
Enablers	An enabler describes the initial realization of a specific NextGen functional component needed to support one or more OIs or other Enablers. Enablers describe material components, such as communication, navigation, and surveillance systems, as well as non-material components, such as procedures, algorithms, and standards.
Enterprise Services	Any or all of the key services that are provided to all COIs throughout NextGen, and can be characterized by the net-centric infrastructure services that provide connectivity and universal access to information; and by services that provide the collection, processing, and distribution of information. This includes SSA, Security Management, Safety Management, Environmental Management, and Performance Management Services.

Term	Definition
Environmental Management System	An organizational business process that consists of four phases. In the first “planning” phase of the NextGen EMS, the organization will identify environmental issues with the potential to constrain future capacity. These will be the focus of tactical, measurable objectives for which improvement initiatives can be undertaken during the second “implementation” phase. During the third “assessment” phase, the effectiveness of these initiatives is monitored and key performance metrics tracked. Monitoring data are then used to support planning at the organization itself in the fourth “review and adaptation” phase. In the NextGen EMS, monitoring data will also be reported at an enterprise level to support NextGen-wide planning.
Equivalent Visual Operations	The concept to provide aircraft with the critical information needed to maintain safe distances from other aircraft during non-visual conditions, including a capability to operate at levels associated with VFR operations on the airport surface during low-visibility conditions. The ANSP personnel delegate separation responsibility to the flight operators. This capability builds on net-enabled information access, certain aspects of performance-based services, and some elements of PNT services and layered adaptive security.
Flight Crew	The individual or group of individuals responsible for the control of an individual aircraft while it is moving on the surface or while airborne.
Flight Object	The representation of the relevant information about a particular instance of a flight. The information in a flight object includes (1) aircraft capabilities, including the level of navigation, communications, and surveillance performance (e.g., FMS capabilities); (2) aircraft flight performance parameters; (3) flight crew capabilities, including level of training received to enable special procedures; (4) 4DT profile and intent, containing the “cleared” 4DT profile plus any desired or proposed 4DTs; and (5) aircraft position information and near-term intent. Standards for the definition of a flight object are in development.
Flight Operator	The organization or person responsible for scheduling, planning, and directly operating the aircraft. Roles within the flight operator include the flight scheduler, flight planner, and flight crew and may reside with one individual or be delegated to separate individuals.
Flight Plan	A collection of data relating to a specific aircraft or formation of aircraft containing all the information necessary for tracking and producing flight progress strips used to control the flight.
Flight Plan Filing and Flight Data Management Services	The management of data related to a flight, from the initial filing of a proposed flight to the closing of the flight plan and the archiving of the data to support performance management analyses.
Flight Planning	A series of activities preformed before a flight that includes, but is not limited to, reviewing airspace and navigation restrictions, developing the route, obtaining a weather briefing, completing a navigation log, filing a flight plan, and inspecting the aircraft.

Term	Definition
Flow Contingency Management	The process that identifies potential flow problems, such as large demand capacity imbalances, congestion, a high degrees of complexity, blocked or constrained airspace, or other off-nominal conditions. It is a collaborative process between ANSP personnel and airspace users to develop flow strategies to resolve the flow problems. Examples of flow strategies include establishing routing to reduce complexity, restructuring airspace, and allocating access to airspace or runways.
Flow Corridor	A corridor is a long “tube” of airspace that encloses groups of flights flying along the same path in one direction. It is airspace procedurally separated from surrounding traffic and special use airspace, and it is reserved for aircraft in that group. Traffic within the corridor must maintain a minimum distance from the edge of the corridor (i.e., the corridor walls have some thickness”).
Flow Strategy and Trajectory Impact Analysis Services	This capability in NextGen provides a common “what if” function to assess potential changes in planned flights, the allocation and configuration of assets, as well as other conditions (e.g., weather, security initiatives, etc.) that may affect flight operations.
Four-Dimensional Trajectory (4DT)	A 4DT represents the “centerline” of a path plus the positioning uncertainty, including waypoint. Positioning uncertainty includes lateral, longitudinal, and vertical positioning uncertainty. Some waypoints within a 4DT may be defined with controlled times of arrival (CTAs), which constrains the uncertainty for planning purposes. The required level of specificity of the 4DT will depend on the operating environment in which the flight will be flown. Associated with a 4DT is the separation zone around an aircraft and the aircraft intent information, which provides near-term information on the expected flight path.
General Aviation	All civil aviation operations other than scheduled air services and nonscheduled air transport operations for remuneration or hire.
Hazards	The objects or elements from which an aircraft can be separated. These include other aircraft, terrain, weather, wake turbulence, incompatible airspace activity, and, when the aircraft is on the ground, surface vehicles and other obstructions on the apron and maneuvering area.
High-density Flexible Airspace	The specific airspace configurations or routes chosen in near-real-time to provide flexibility and maximize arrival and departure throughput. It is smaller than or lies within high-density protected airspace.
High-Density Protected Airspace	The charted airspace protecting high-density terminals that is somewhat larger than the actual airspace used operationally. Statically defined for low-capability aircraft that do not have access to real-time updates of airspace definition.
Human Factors	The discipline concerned with the understanding of interactions among humans and other elements of a system. It applies theory, principles, data, and other scientific methods to system design to optimize human well-being and overall system performance.
Human-Centric	The ATM system is designed around the capabilities and limitations of humans. It assigns functions to humans that are best performed by them, and it provides automation assistance when it can improve decision making or make the humans' tasks easier. It does not imply that humans are always in direct control.

Term	Definition
Information Services	A service that provides data and information to subscribers when and where needed in a common format. Ensures questions raised by data consumers are answered correctly and consistently.
Infrastructure Services	A service that provides communications connectivity to ensure information flows work reliably to support information communications and sharing functions.
Integrated Risk Management (IRM)	A process that includes prognostic tools, models, and simulations at the strategic, operational, and tactical level to support all stakeholder decision makers and managers in the grafting of cost-effective “best practices” into the design, acquisition, deployment, and operation of aviation security system assets and infrastructures. Knowledge bases concerning threats, vulnerabilities, and practices are tailored to user profiles that proactively determine need/authorization to know.
Intelligent Agents	Within the context of this operational concept, refers to a computational system that includes the following characteristics: is aware of constraints, has goals, and operates autonomously within its construct to identify information or opportunities for human action. It is customized for an area or task, is adaptive, knows the user's preferences/interests, and can operate on their behalf (e.g., by narrowing the choices available through auto-negotiation). As such, this concept's definition is consistent with commonly accepted industry standards.
Intent	Information on planned future aircraft behavior, which can be obtained from the aircraft systems (avionics). It is associated with the commanded trajectory and takes into account aircraft performance, weather, terrain, and ATM service constraints. The aircraft intent data correspond either to aircraft trajectory data that directly relate to the future aircraft trajectory as programmed inside the avionics or the aircraft control parameters as managed by the automatic flight control system. These aircraft control parameters could either be entered by the flight operator or automatically derived by the flight management system.
Layered Adaptive Security	The security system will be constructed in “layers of defense” to detect threats early and prevent them from meeting their objective while minimally affecting efficient operations. Airports and aircraft will be designed to be more resilient to attacks or incidents. Building on the “net-enabled information access” and “performance-based services” capabilities, risk assessments will begin well before each flight so that people and goods will be appropriately screened as they move from the “airport” curb to the aircraft, or as they support aerodrome/aircraft operations. As technology matures, screening will be unobtrusive and more transparent to the individual. All people and cargo that “touch” or are carried by an aircraft will be positively identified. Responses to anomalies and incidents will be proportional to the assessed risk of the involved individuals or cargo.
Managed Airspace	An Air Navigation Service Provider provides Air Traffic Management Services; separation is delegated as appropriate to equipped aircraft.
Metroplex	A group of two or more adjacent airports whose arrival and departure operations are highly interdependent.

Term	Definition
Near-Space Airspace	Low-density, low-complexity airspace at very high altitudes that accommodates a wide range of special operations (e.g., high-speed reconnaissance aircraft, aerostats, long-endurance orbiting UAS).
Net-Centricity	The realization of a globally interconnected network environment, including infrastructure, systems, processes, and people that enables an enhanced information sharing approach to aviation transportation.
Net-Enabled Information (NEI)	An information network that makes information available, securable, and usable in real-time to distribute decision making. Information may be pushed to known users and is available to be pulled by other users, including users perhaps not previously identified as having a need for the information.
Net-Centric Operations	The decision support and other applications using NEI for information transfer and retrieval.
NextGen Decision Oriented Tool (NDOT)	A tool that incorporates observations, forecasts, model/algorithm data, and climatology, including surface observations and weather aloft to allow full integration of weather into traffic flow decision making.
Network Enabled Weather	The 4D net-centric weather information network that publishes discoverable past, current, and future weather data and information for decision makers; enabling weather situational awareness when planning and executing operations across the full spectrum of the Air Transportation System.
Non-Managed Airspace	Uncontrolled, low-altitude airspace where no ANSP services are provided, except as required to coordinate entry to a different class of airspace.
Oceanic Airspace	That airspace over the oceans of the world, considered international airspace, where oceanic separation and procedures per ICAO are applied. Responsibility for the provisions of ATC service in this airspace is delegated to various countries, based generally upon geographic proximity and the availability of the required resources.
Performance-Based Navigation (PBN)	RNAV based on performance requirements for aircraft operating along an ATS route, on an IAP or in a designated airspace. Note: Performance requirements are expressed in navigation specifications (RNAV specification, RNP specification) in terms of accuracy, integrity, continuity, availability, and functionality needed for the proposed operation in the context of a particular airspace concept.
Performance-Based Operations	Use of performance capability definition versus an “equipment” basis to define the regulatory/procedural requirements to perform a given operation in a given airspace.
Performance-Based Services	There are multiple service levels aligned with specified user performance thresholds to provide choices to users depending on needs, required communication, navigation and surveillance performance, environmental performance criteria, security parameters, and so forth. Services will be flexible according to the situation and consolidated needs of the users. Services vary from area to area in terms of airspace and “airport” surfaces, and they vary with time as needs dictate. Preferences are established based on user capability, equipage, training, security, and other considerations. The performance-based approach is used to analyze risks (e.g., safety, security, and environment) instead of “equipment-based” approaches. The performance-based services capability will enable a definition of service tiers and allow the government to move from equipment-based regulations to performance-based regulations.

Term	Definition
Position, Navigation, Timing (PNT) Services	A service that enables the ability to accurately and precisely determine one's current location and orientation in relation to one's desired path and position; apply corrections to course, orientation, and speed to attain the desired position; and to obtain accurate and precise time anywhere on the globe, within user-defined timeliness parameters.
Required Navigation Performance (RNP)	A statement of the navigational performance necessary for operation within a defined airspace. The following terms are commonly associated with RNP: (a.) - RNP Level or Type (RNP-X). A value, in nautical miles (NM), from the intended horizontal position within which an aircraft would be at least 95-percent of the total flying time. (b.) - RNP Airspace. A generic term designating airspace, route(s), leg(s), operation(s), or procedure(s) where minimum required navigational performance (RNP) has been established. (c.) - Actual Navigation Performance (ANP). A measure of the current estimated navigational performance. Also referred to as Estimated Position Error (EPE). (d.) Estimated Position Error (EPE) - A measure of the current estimated navigational performance. Also referred to as Actual Navigation Performance (ANP). (e.) - Lateral Navigation (LNAV). A function of RNAV equipment which calculates, displays, and provides lateral guidance to a profile or path. (f.) - Vertical Navigation (VNAV) - A function of RNAV equipment which calculates, displays, and provides vertical guidance to a profile or path.
Required Navigation Performance Level or Type (RNP-X)	A value, in nautical miles (NM), from the intended horizontal position within which an aircraft would be at least 95 percent of the total flying time.
Route	A path through space with no time component. Unlike corridors, aircraft can cross routes as operational need requires, with proper separation provided to all aircraft.
Safety Assurance	The independent oversight function that tests, evaluates, and certifies, as necessary, products and processes to ensure that they are safe for the public and stakeholders.
Safety Culture	The product of individual and group values, attitudes, competencies, and patterns of behaviors that determine the commitment to, and the style and proficiency of, an organization's health and safety programs.
Safety Management System (SMS)	The process that provides a systematic method for managing safety. The four components of an SMS are policy, architecture, assurance, and safety promotion.
Safety Risk Management (SRM)	The set of processes and practices by which a concept and its operation are designed and made to be safe.
Self Separation Airspace	That airspace where aircraft self-separation enables maximum user flexibility in exchange for high-capability equipage of the aircraft.
Separation Management (SM)	The function of ensuring aircraft or vehicles maintains safe separation minima from other aircraft or vehicles, protected airspace, terrain, weather, or other hazards. The function may be performed by ANSP personnel, the flight operator, and/or automation.
Separation Minima	The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of ATC procedures.

Term	Definition
Service Oriented Architecture (SOA)	A design for linking computational resources (principally, applications and data) on demand to achieve the desired results for service consumers (which can be end users or other services). The Organization for the Advancement of Structured Information Standards (OASIS) defines SOA as the following: <i>A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with, and use capabilities to produce desired effects consistent with measurable preconditions and expectations.</i>
Shared Situational Awareness (SSA)	The sharing of information among the processes and applications that constitute the information services function to the stakeholders in the system.
Situational Awareness	A service provider or operator's ability to identify, process, and comprehend important information about what is happening with regard to the operation. Airborne traffic situational awareness is an aspect of overall situational awareness for the flight crew of an aircraft operating in proximity to other aircraft.
Special Activity Airspace (SAA)	Any airspace with defined dimensions within the National Airspace System wherein limitations may be imposed upon aircraft operations. This airspace may be restricted areas, prohibited areas, military operations areas, air ATC assigned airspace, and any other designated airspace areas. The dimensions of this airspace are programmed into URET and can be designated as either active or inactive by screen entry. Aircraft trajectories are constantly tested against the dimensions of active areas and alerts issued to the applicable sectors when violations are predicted.
Staffed NextGen Tower (SNT)	A facility where surface and tower services are provided by ANSP personnel, providing other-than-direct visual observation, which may or may not be located at the facility.
Stakeholders	All entities that have a vested interest in ensuring the safest and most efficient operation of the NextGen. Through performance metrics analysis and research, these entities see that the proper training is coordinated and provided to the appropriate COIs, and that other enterprise needs are met.
Surveillance Services	This service integrates cooperative and non-cooperative airport surface and airspace surveillance systems, fostering real-time air and airport situational awareness and enhancing safety and security.
Trajectory Management (TM)	The function of fine-tuning trajectories as required by the airspace plan or an active flow contingency management initiative to minimize pairwise contention and ensure efficient individual trajectories within a flow.
Trajectory-Based Operations (TBO)	The use of 4D-trajectories as the basis for planning and executing all flight operations supported by the air navigation service provider.
Transition Airspace	Airspace that allows aircraft to transition from one classification of airspace to another while maintaining separation from other airspace and aircraft entering and exiting adjacent airspace.
Unmanned Aircraft System (UAS)	In its most basic sense, a UAS is any aircraft that can be flown without a human on board. UAS is a preferred term by RTCA, FAA, and DOD. UAS includes: All classes of aircraft (airplanes, helicopters, airships, and translational lift aircraft), Aircraft Control Station, Command & Control Links, and autonomous, semi-autonomous, or remotely operated vehicles. Other commonly used terms include Unmanned Aerial Vehicle (UAV), RPA, Remotely Piloted Vehicles (RPV), and Drone/Model/RC Aircraft.

Term	Definition
Weather Information Services	A common service providing the following generic capabilities: sensor configuration, observation, forecast, and history.

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